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HYDRAULICS LABORATORY

FLOOD-CONTROL CHANNELS RESEARCH PROGRAM

MISCELLANEOUS PAPER HL-90-10

FLOOD-CONTROL CHANNEL NATIONAL INVENTORY

by

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A US Army Corps of Engineers-wide survey of flood-control project design procedures and related experiences was conducted in 1985 to record the following: (a) specific information about various streams and promising improvement techniques, design methods used in the past, centers of experience for certain type projects, points of contact by name, and stream types existing in each Corps Division; (b) problems and noteworthy experiences pertaining to project design, environmental issues, local cooperation, Corps District operation and maintenance activities, and project review; and (c) insight into future research and guidance needs for bank protection (particularly riprap), grade control structures, and stable channel design in general.

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SUMMARY

During 1985, the US Army Engineer Waterways Experiment Station Hydraulics Laboratory conducted a Corps of Engineers- (CE-) wide study (referred to as the "inventory") into various aspects concerning the design of stable flood-control channels in natural materials. The results of the inventory, as presented in this report, are related in some way to flood-control project design and review procedures. Topics covered include stream types, points of contact, current state of approved design guidance, design problems, promising new techniques, project review problems, riprap design, grade control structure design, operations and maintenance, environmental issues, research needs, and other pertinent topics. Specific conclusions and recommendations are listed in Part VI of this report.

In general, the results of this inventory include the following:

a. Specific information about various streams and promising improvement techniques, design methods used in the past, centers of experience for certain type projects, points of contact by name, and stream types existing in each CE Division.

b. Problems and noteworthy experiences pertaining to project design, environmental issues, local cooperation, CE District operation and maintenance activities, and project review.

c. Insight into future research and guidance needs for bank protection (particularly riprap), grade control structures, and stable channel design in general.

PREFACE

This survey of flood-control project design procedures and related experiences was conducted by personnel of the Hydraulics Laboratory, US Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, during 1985. It was conducted as a part of the Flood-Control Channels Research Program, sponsored by Headquarters, US Army Corps of Engineers (HQUSACE), under Work Unit No. 32549, "Controlling Stream Response to Channel Modification."

This study was performed by Mr. Andrew J. Reese, Dr. John J. Ingram, and Dr. Bobby J. Brown, Hydraulic Analysis Branch, Structures Division, Hydraulics Laboratory. Mr. Reese, formerly of the Hydraulic Analysis Branch, and now with MCI Consulting Engineers, Inc., Nashville, TN, prepared this report in draft form. In 1988, the draft report was reviewed by numerous Corps hydraulic designers, who provided suggestions for revision. Mr. Robert W. McCarley, Math Modeling Branch (MMB), Waterways Division (WD), Hydraulics Laboratory, incorporated the comments resulting from the review and prepared the report in final form.

The survey was performed under the direction of Messrs. Frank A. Herrmann, Jr., Chief of the Hydraulics Laboratory; R. A. Sager, Assistant Chief; and Mr. Marden B. Boyd, Chief, WD. Technical review of the report was provided by Mr. William A. Thomas, WD, and Mr. Ronald R. Copeland, MMB. HQUSACE Technical Monitor was Mr. Thomas E. Munsey.

Commander and Director of WES during preparation of this report was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

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PART I: INTRODUCTION

1. The purpose of this report is to document the results of a nationwide inventory of US Army Corps of Engineers District activities related to the design and construction of flood-control channels in natural materials. The inventory was conducted during 1985 by the Hydraulics Laboratory, US Army Engineer Waterways Experiment Station (WES) and the draft report was reviewed by numerous Corps hydraulic design engineers in 1988.

2. The specific purposes of the inventory were to

   a. Identify points of contact within each District/Division for information exchange.

   b. Identify promising and innovative design and analysis techniques that could be applied at the District level and potentially require a minimum of time and data.

   c. Identify priority research needs related to the design and analysis of flood-control channels in natural materials.

   d. Identify streams as potential candidates for further study.

   e. Identify centers of expertise for various designs.

   f. Identify problem areas including those which are systematic, regional, keyed to stream type, or keyed to a certain design type.

   g. Seek to correlate stream and successful design types.

   h. Gather and analyze information on special topics to include riprap design, grade control structure design, project review, operation and maintenance (O&M), and environmental concerns.

PART II: BACKGROUND

3. The successful design of stable channels in natural materials and an accurate analysis of possible channel responses to project modifications have been identified as priority concerns by the Headquarters, US Army Corps of Engineers (HQUSACE). The primary sources of detailed Corps guidance for the hydraulic design of flood protection projects are Engineer Manuals (EM) 1110-2-1405 (HQUSACE 1982a), 1110-2-1601 (HQUSACE 1970), and 1110-2-4000 (HQUSACE 1989). However, the constraints of funds, time, and available data often preclude a detailed or comprehensive analysis by planners and hydraulic/hydrologic engineers. This situation points to the need for pragmatic, experience-based design guidance that can be applied within these constraints.

4. In 1983 the Hydraulics Laboratory was asked to explore ways of developing improved design guidance for stable channels in natural materials. The initial thrust of this effort had several objectives:

- a. To enable determination of acceptable geometry and stabilization measures for improved flood-control channels.
- b. To develop technical guidance for use by District design personnel with limited experience.
- c. To identify plan formulation, survey, hydrologic, and geotechnical inputs required for project design.

5. The product of this effort was envisioned to be a loose-leaf handbook that relates stream "types" (see Appendix A for definition of stream types) to successful and acceptable channel improvement methods. The development of this handbook was to proceed from the most common stream types to the least common. A two-phased approach for developing the handbook has been suggested as follows:

- a. Phase 1: Develop and document channel types. Organize into number per type along with successful or unsuccessful channel improvement methods.
- b. Phase 2: Develop (type by type) design methodology, including necessary charts, nomographs, photographs, and data tables.

This report covers the results to date under Phase 1 of the envisioned efforts to provide available design guidance and criteria.

Preparation for Pilot Study

6. Phase 1 was initially undertaken in the form of a pilot study

conducted of streams under the responsibility of the US Army Engineer District, Vicksburg, Vicksburg, MS. The purpose of the pilot study was to assess stream data availability and ease of collection and feasibility of the inventory effort. Prior to the initiation of the pilot study, a literature search was conducted to determine the precise parameters needed for stable channel design and analysis, and the availability of information/data on these parameters.

7. A rather exhaustive checklist of the essential parameters has been completed. They are listed on the Stream Reach Inventory Form in Appendix B. If the form could be completed in detail, information on a number of regime, qualitative, and simple quantitative analysis techniques would be readily available. Additionally, all computerized stable channel design programs contained in the Conversationally Oriented Real-Time Programming System (CORPS) could be run using input data from this form. The form could also serve as a comprehensive checklist of important parameters for stable channel analysis.

Pilot Study

8. During the period September through November 1984, the pilot study was conducted of streams within the Vicksburg District. The District was divided into topographically similar regions, stream candidates were selected (without prior determination of data availability), and data were collected. Wherever multiple methods were available for measurement of various parameters, District personnel were asked to indicate the preferred method(s) or technique(s).

9. An average time of 3 man-days was required to study each stream. With this level of effort, no field trips were involved and additional data were required on all streams. Total time required to study each stream was estimated to be 6.2 man-days. At an average of 10 streams per District, a total of about 350 streams would need to be surveyed. This would require a total of about 8 man-years of effort, which was considered excessive.

The Inventory Approach

10. The present inventory approach resulted from a desire to obtain significant information quickly at minimal cost. This involved "brainstorming" sessions with key District personnel to identify facts about stream

types, designs, and problem areas. This approach did not permit a comprehensive study of the streams, but did enable development of a list of priority items for future emphasis.

PART III: INVENTORY PROCEDURES

11. A number of preliminary activities took place prior to physically conducting the subject inventory. The following paragraphs describe these activities.

Point of Contact

12. Points of contact in the Division offices were provided by HQUSACE. Contacts at the time of the inventory, together with the contacts as of late 1989 listed in parentheses, are shown in Table 1. The inventory was limited to Divisions within the continental United States plus the Alaska District.

13. District points of contact were then developed from the recommendations of the Division representatives. Table 2 lists the District points of contact used for the inventory, with their replacements as of late 1989 also noted in parentheses. (Note: A computerized, Corps-wide "bulletin board" for hydraulic points of contact was suggested to supplement and update Tables 1 and 2. The bulletin board could be used to query other Districts rapidly for their experiences with a new project design procedure or problem.)

Stream Data Development

14. District project map books, HQUSACE continuing construction computer printouts, and personal contacts were sources of information for identifying target streams in each District. After investigating several methods for classifying stream types, the methodology developed by Schumm (1981) was selected. The two-page coding sheet shown in Appendix A was designed for partitioning the streams by "type." Different types of stream modification were also categorized and given two-letter identity codes, also defined in Appendix A. All stream information available in the District offices was coded on these sheets and additional pertinent facts included during the separate meetings with each District.

Agenda Development

15. When the inventory procedures were being developed, it was requested

that specific related topics be added (e.g., O&M). Eventually, a meeting agenda in the form of questions was completed to encompass most of the needs expressed. This agenda is given in Appendix C. The following general topics are included: (a) general flood-control channel design, (b) design problems, (c) design procedures, (d) research needs, (e) riprap, (f) grade control, (g) O&M, (h) environmental concerns, and (i) project review.

Procedure

16. The inventory procedure was as follows: (a) develop stream data for each District; (b) send a contact letter to each Division representative; (c) contact each Division representative by phone or in person; (d) send each District representative a letter containing a meeting agenda and a tentative list of streams to be discussed; (e) meet with each District; (f) send a draft copy of the pertinent trip report to each District for review; and (g) revise the trip report based on comments received. In addition, the results of the inventory were partially checked by asking students in the two "Hydraulic Design for Project Engineers and Planners" short courses taught at WES in 1985 to fill out a questionnaire. Analysis of the completed questionnaires confirmed the accuracy of the inventory in most cases.

PART IV: INVENTORY RESULTS

17. Inventory results reported in this part are partitioned into the same three parts as the Inventory Meeting Agenda shown in Appendix C, i.e., General Questions, Special Topics, and Specific Streams. Part V of this report gives further details on the analysis of results. A detailed breakdown of responses to questions asked at the meetings is given in Appendix D. Table D1 (pages D3 through D35) shows a breakout of common responses to questions by District. Table D2 (pages D36 through D45) totals responses by questions from all Districts. For example, under Question 1 (Table D2), "Types of Flood-Control Problems," 15 Districts stated that aggradation/silting was a flood-control problem (see pages D3, D14, and D25). Tables D3 through D12 (pages D46-D55) show a breakdown by Corps Division of stream type versus modification type, and Tables D13 and D14 (pages D56-D57) show the totals for all Divisions. The figures in this Part help clarify the material found in Appendix D.

18. All responses to the questions depended heavily on the backgrounds of the meeting attendees. The importance of assembling a variety of personnel representing different areas of expertise was frequently emphasized. Each District was asked to appoint personnel from hydraulics, soils, O&M, planning, environmental, and other disciplines that could supply input. The most valuable and comprehensive information on streams was obtained from the Districts that cooperated most with this request.

General Questions

Question 1

19. Types of flood-control problems. This section includes problems involving virgin streams, streams altered by someone other than the Corps of Engineers, and streams altered by the Corps of Engineers. These are problems that cause or aggravate flooding (such as floodplain encroachment, ice jams, or levee failure), or cause or influence deterioration of a stable stream environment (such as bank caving, meandering, debris attack on a structure, or scour). Even though most Districts mentioned it, the obvious reason, "locally inadequate channel size," was not specifically included in Appendix D as a major cause of flooding problems.

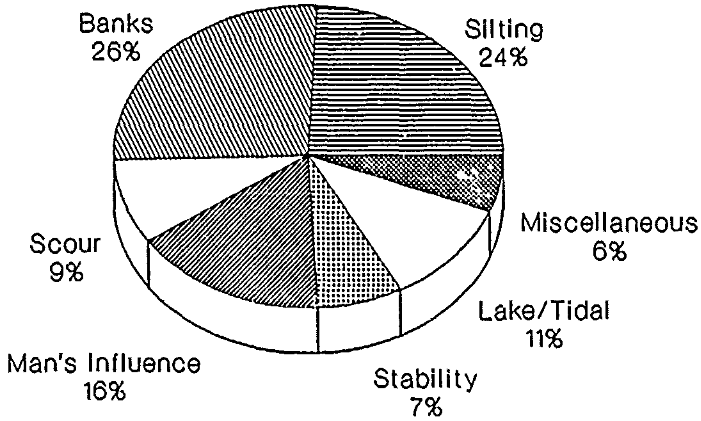

Figure 1. Types of flood-control problems

20. Figure 1 summarizes the 173 responses to the question on types of flood-control problems. As indicated, the two leading responses relate to bank instability (26 percent) and silting problems (24 percent). Bank instability includes toe and thalweg attack, debris attack, and foundation failure. General meandering and braiding are included under stability. Silting problems include general aggradation, channel filling, clogging and bar stabilization, and specific site deposition. (See Appendix D for detailed breakdown of information.)

21. Other categories in order of number of times mentioned are (a) man's influence (urbanization, floodplain encroachment, in-stream mining, structural under- or over-sizing); (b) lake and tidal effects (general, wave attack, rising levels, backwater effects); (c) scour (general, point, at structures); (d) stability; and (e) miscellaneous (ice jams, interior drainage, fault lifting).

22. Most common stream types. Paragraph 14 gives the sources of information on stream types and the categorization technique. Additional stream types were added to reflect special types not otherwise indicated by the S-M-B classification (S = suspended load streams; M = mixed-load streams; and B = bed-load streams). See Appendix A for definition drawings of stream types and the stream questionnaire. District personnel sometimes found it difficult to categorize certain streams, even when drawings and descriptions of each different type were provided. Of course, different reaches of a single stream may fit different categories. Subcategories 2 and 3 under S-, M-, or B-type streams were the most common (meandering or alternate side bars). Streams flowing over bedrock were only incidentally included in the inventory and were

mentioned about as frequently as tidal streams.

23. Figure 2 gives a breakdown of stream type by percent of each type. Figures 3 through 5 show the percentages of each stream subtype. These figures are based on Table D1 (pages D3-D35). The most common stream types are mixed-load streams of the M2 (fairly stable, alternate bars) and M3 (true meandering channel, wide bars) subtypes. These comprise about 18 percent and 17 percent, respectively, of the total. The next most common is S3 (narrow, highly sinuous, small point bars) at about 16.5 percent.

24. Figure 6 shows the Corps Division boundaries for Civil Works Activities. Because Corps boundaries are based on river basin boundaries and not topography, attempts to divide stream type on the basis of Districts or Divisions met with minimal success due to the wide range of different types within each District or Division.

25. Present project concerns. The data in this part of Tables D1 and D2 (Appendix D) were obtained from two sources. First, District personnel identified ongoing projects and future projects. Secondly, project map books were investigated for projects completed after about 1970.

26. In a recent article, Robert Dawson (1986), past Assistant Secretary of the Army for Civil Works, stated that new cost-sharing rules based on the passage of Public Law 99-662, the Water Resources Development Act (WRDA) of 1986, will "undoubtedly lead to smaller projects on average than have been typical in the past." In discussions with various Districts, it was obvious that small, relatively low budget projects (Section 205's, 208's, 214's) dominate the scene. In most Districts, few, if any, large projects were in progress. This fact has a positive impact on the types of design guidance, procedures, and criteria required by the Districts. (Note: The St. Paul District reported when reviewing the draft of this report that their District had experienced an increase in the number of large projects since passage of the WRDA. The Act actually authorized several large projects and set cost-sharing levels on small projects the same as for large projects, which tended to decrease the number of small projects.)

Question 2, common methods used

27. Figure 7, developed from Table D13 (page D56), shows stream modification (or improvement) methods used for actual projects. Levee work is most common with 19 percent, followed closely by channel improvement and bank

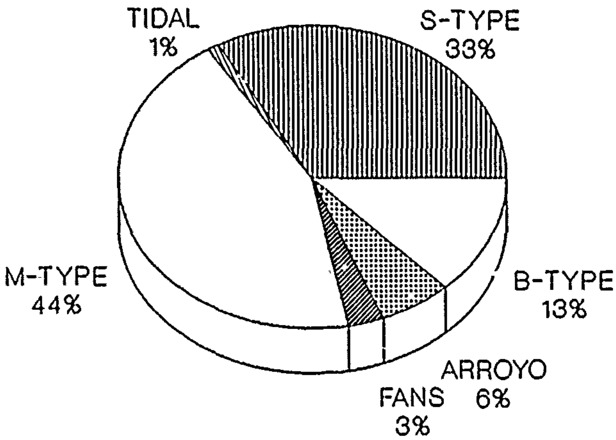

Figure 2. Stream type distribution*

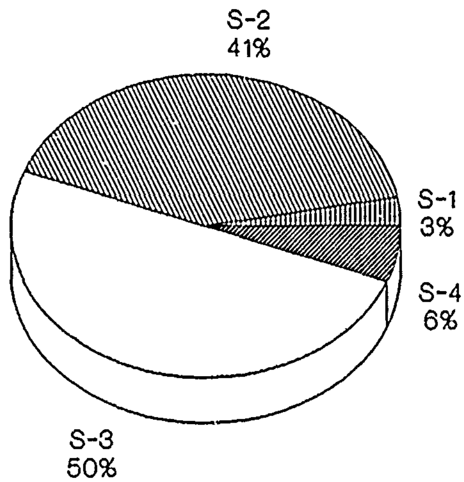

Figure 3. Suspended load (S-type) stream distribution*

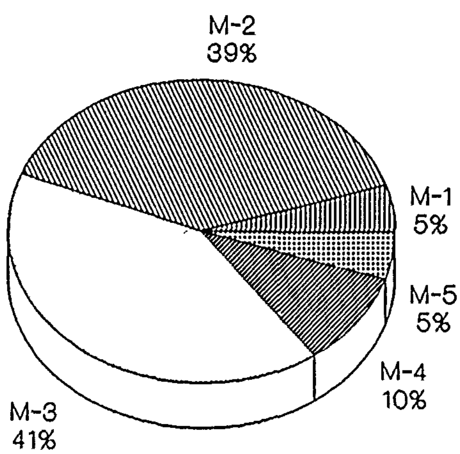

Figure 4. Mixed-load (M-type) stream distribution*

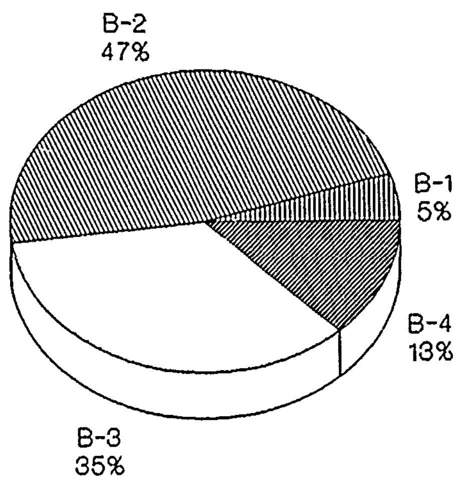

Figure 5. Bed-load (B-type) stream distribution*

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* See paragraph 14 for sources of information and Appendix A for definitions of stream types and subtypes.

Figure 6. Divisions for Civil Works Activities

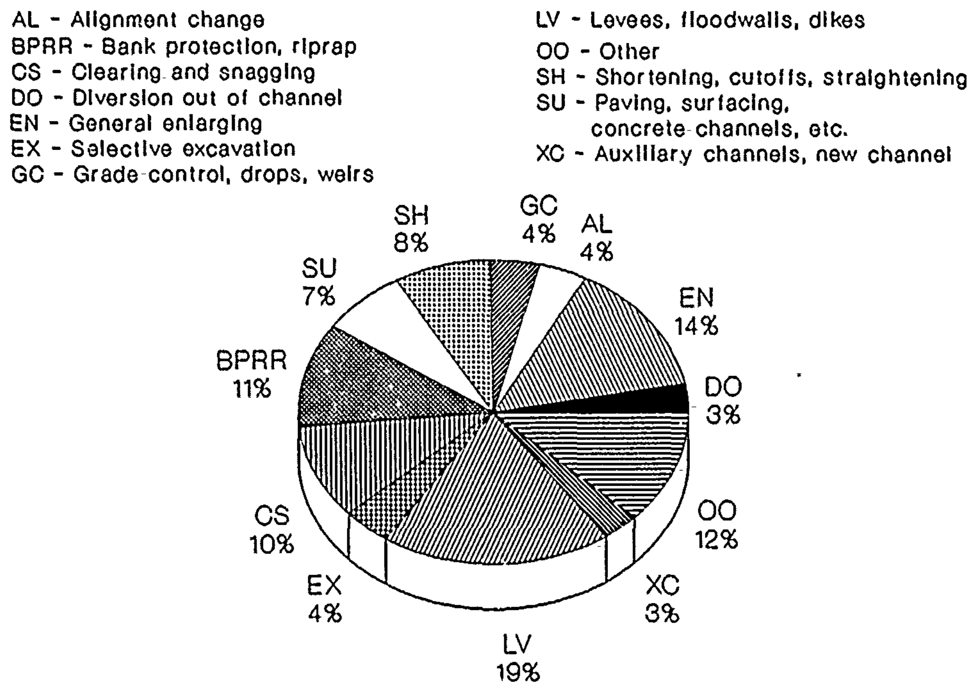

Figure 7. Common stream modification methods used (see Appendix A for complete list of improvement codes)

protection. Clearing and snagging and channel shortening and straightening were also common methods listed.

28. Both channel improvement and levee work usually involve bank protection. (However, many smaller Section 14 bank protection projects were not included in this inventory.) Bank protection is thus the single most frequently occurring stream modification method in the Corps. Results of studies under the Streambank Erosion Control Evaluation and Demonstration Act of 1974, Section 32, Public Law 93-251 (commonly referred to as the Section 32 Program) indicated that the total annual damages resulting from streambank erosion amounted to about $90 million in 1969 dollars (HQUSACE 1981). Of the commonly used bank protection methods, riprap is the leader by far.

29. Many Districts commented that, although the methods included in Figure 7 are the most common, they are often unpopular with local sponsors for a number of reasons, including required resources beyond their means, even when costs are shared by the Federal government.

30. Some Districts reported that the choice of the method was often based on what had "worked" in previous projects or on the subjective preferences of particular designers or reviewers. Untested methods and designs, though less expensive, were often not selected. Many designers expressed a

desire for freedom to try newer, more imaginative designs and methods to meet the strict resource constraints of some cost-shared projects. They felt some Corps designs are more expensive and conservative than necessary. Some Districts have used methods not commonly found in the rest of the Corps. These methods are reported by District in Appendix E.

Question 3, postconstruction problems

31. Most postconstruction problems are associated with the response of an alluvial stream to some change in one or more of its controlling parameters (see Question 3, Table D2, page D39). If the channel is widened, aggradation may occur. If the channel is straightened or steepened, then degradation may occur in some cases, causing "headcuts" to move upstream, undermining highway bridges and undercutting banks. A meandering or braided stream closely confined within protected banks or levees may attempt to migrate through these structures (confinements) as part of its natural instability.

32. Hydraulic structures also can alter streams and cause undesirable changes. Scour and reduced flows downstream of dams have lowered base levels, causing degradation in tributaries. Clogging of streams by tributaries carrying heavy sediment loads and entering below flow-control dams has had an adverse effect. Scour downstream from concrete channels, drop structures, or riprap-protected sections has in many cases eventually undermined those structures.

33. Figure 8 divides postconstruction problems into six groups. The most common problem group is bank or toe failure (39 percent). This group includes a number of modes of riprap failure (see section on riprap design beginning with paragraph 45). The second most common problem at 29 percent is general vertical instability. This includes general aggradation or degradation, headcutting, and choking by vegetation, causing reduced conveyance and deposition. Other categories are horizontal instability, local scour or

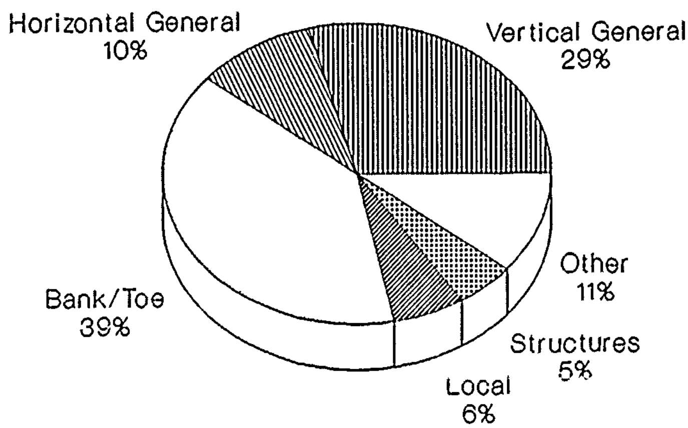

Figure 8. Postconstruction problems (see paragraph 33)

deposition, and structure-mobile boundary integrity (e.g., transition design or flanking problems).

34. The reasons for postconstruction problems are numerous. The Corps continues to emphasize consideration of channel stability in its project analysis. However, inexpensive, yet accurate and simple tools for this analysis are not available. Adequate sediment data are usually nonexistent. And, too, streambank failure mechanisms are sometimes difficult to identify. Even such time-saving aids as microcomputers with adequate software are not always readily available. Problems are sometimes recognized soon after completion of a structure, but funding may not be immediately available to rectify the situation.

Question 4, design scenarios
<u>and time and money constraints</u>

35. The most common adverse statement heard concerning present Corps design practices for flood-control projects is that there is not enough time and/or funds allocated during initial study phases to perform an adequate design. Districts often feel it is not possible to produce an adequate survey report, feasibility study, and plans and specifications within the budget constraints, management structure, and timing of study funds inherent in the smaller projects. Yet, the requirements of the review system (see the section on project review beginning with paragraph 61) and conservative design criteria demand a detailed design identical to that required for much larger and higher budgeted projects. Several designers reported pressures on them to make estimates of certain design parameters at a reconnaissance level and then adhere to these early estimates throughout the design process in spite of their preliminary nature.

36. New procedures contained in the WRDA of 1986 may impact this problem by forcing projects to construction on a shorter time schedule and involving local sponsors in the finances earlier in the planning process. However, some Districts are concerned with the perception of many municipalities that project planning and design take too long, the projects end up costing too much, and are often more sophisticated than envisioned. In many cases local cooperation may be lost because of administration changes or because the community lost sight of the problem due to long periods of time between significant storm events.

37. Several suggestions were made to remedy these situations:

a. A disproportionate amount of the available funds is often allocated to such areas as project management and environmental analysis at the expense of engineering analysis. Adequate funding should be provided early enough for engineering analysis to determine if a project is economically and physically feasible and advisable. Available funds should be allocated according to technical priorities with flexibility for redistributing funds as needed.

b. Recommended guidelines are needed for low-cost designs and simple analysis techniques. More freedom should be given for innovative designs. Funding should be provided for demonstration projects to test innovative designs.

c. Too much often unnecessary detail is required in study reports. They should be streamlined to allow maximum effort to be spent in data collection and design, not report writing.

d. Reviews of relatively small projects should be delegated to the lowest possible echelon as a time-saving measure and to ensure regional and local familiarity with the projects.

e. Additional funds should be allocated for detailed inspection of completed projects, especially by the design engineers themselves. A data base of successful designs and design parameters could then be developed. Basic prototype measurements and data collection would provide the basis for improvement of existing inadequate design criteria.

f. More flexibility should be given for assessing and assigning project benefit/cost ratios. Section 914 of the WRDA may help through new provisions for evaluating flood damage reduction measures for which the Federal share is less than $3 million.

g. More freedom should be given to set the physical limits of smaller projects far enough upstream, downstream, and streamward to actually solve the problem.

h. More Districts should emphasize the process for conducting small project planning and design, rather than the end product. Districts should experiment with innovative, organizational structures (e.g., matrix management) for planning small projects.

i. Districts often do not use the recommended available guidance or mandatory considerations for various levels of report preparation. More emphasis should be placed here and perhaps a one- or two-page checklist published simply as a memory aid.

j. Communities are often unaware of available assistance programs and funding sources. Sections 922 and 942 of the WRDA provide for a wider range of technical services to local governments on a cost-reimbursable basis and for technical assistance for clearing and snagging of navigable streams on a 50 percent Federally funded basis. Communities should be fully appraised of all assistance programs and possibilities available to them, including sources other than the Corps.

k. Corps-sponsored training courses should "walk through" the design process step by step, using a number of examples along with lectures on basic techniques.

Question 5

38. Design criteria needs. In an effort to help direct future research, Districts were asked to identify the design guidance they need most. The responses not included under one of the special topics (i.e., riprap, grade control) are included under question 5. Since such a wide variety of design guidance needs were expressed, there was no way to group them logically for practical use. They were, therefore, arranged alphabetically by key word in Table D1. It is hoped that these needs will align with those included in the Corps Research Needs System (HQUSACE 1982b) and, perhaps, also provide some new direction.

39. Two general topics were the most prominent:

a. Guidance on the use of a number of different streambank protection methods (including gabions, detailed riprap guidance, and a reevaluation of the Section 32 Program results). Streambank protection is the most common type of work done in the Corps. Riprap may not always be acceptable to local sponsors due to the lack of availability, high cost, difficulty to maintain, safety hazards, vandalism, or aesthetics. Yet, little guidance exists for the use of the many commercially available products or different design methods (e.g., vegetation combined with matting structure). See "Special Topics" for further information.

b. Guidance on channel stability/sediment transport analysis techniques that could be quickly performed in the office. Detailed sediment transport analysis is often beyond the technical capabilities of many engineers and the budgets of most projects. Additionally, adequate data are almost always not available for smaller projects. Some type of method or methods are needed that will give (1) reasonable estimates of transport volumes; (2) indication of type and magnitude of stability problems; and (3) sufficient flexibility to aid in assessing alternative designs.

40. Guidance for some of the topics mentioned already exists, either in the form of articles or publications, or in the form of expertise on similar projects (see next section) in the Corps. Districts would greatly benefit from the following:

a. More cross-communication on common project concerns through the use of newsletters, symposia, and/or training courses. Several Districts suggested that some courses taught at the US Army Engineer Hydrologic Engineering Center (HEC) and WES be primarily for the purpose of such cross-communication. Perhaps they could be symposia rather than courses.

b. Being able to conveniently access WES, HEC, HQUSACE, or other Corps agencies as centers of expertise for assistance in such areas as background research, one-stop consulting, and numerical and physical models. Several Districts stated that they avoid using WES for physical models because of the excessive time it usually takes to get results.

c. Better communication and more efficient documentation and updating of the sources of information that already exist, but are frequently unknown to Corps design engineers. Examples include the Hydraulic Design Criteria, Engineer Technical Letters (ETL's), EM's, various Corps and commercially available short courses, CORPS, programs available from individual Districts and other laboratories, and commercially available software.

41. Expertise. Every District has expertise in some aspect of flood control. However, there is often a general reluctance to claim expertise in a certain area beyond actual experience. All Districts are cautious about entering design environments wherein they have little or no experience. Obviously, many other topics could be listed under this heading, but only those specifically mentioned by the Districts were included in this report. Some topics were included because Districts may have used particular methods, other than those found in official Corps guidance, and found them to be successful, even though specific expertise was not claimed.

42. The section in Table D1 (pages D11, D21, and D33) on "Miscellaneous Expertise or Knowledge" should, therefore, not be considered as all-inclusive. Appendix E contains a listing of specific stream improvement methods that were either mentioned during the meetings or reported later in writing.

43. Several Districts suggested that someone at the HQUSACE level should be able to accurately assess expertise Corps-wide and direct Districts to the right sources. Knowledge of available expertise was felt to be an important need.

44. The idea of setting up centers of expertise in certain design areas was often mentioned. Most Districts felt that the idea was good in theory, but may not be workable in practice for a number of reasons, including the following:

a. The unwillingness of many Corps employees to relocate.

b. The parochialism of many Districts.

c. The need for knowledge of local unique conditions (not the least of which is political).

d. The requirement for this expertise to be accessible on a day-to-day basis.

e. The limitations on the spread of knowledge and training that would occur with formation of technical elite groups.

Special Topics

Riprap design

45. Failure causes. Figure 9 shows the most commonly reported causes of riprap failure. The figure does not indicate either the number of streams affected by a certain failure mode or the dollar amounts involved. Figure 9 was constructed simply by summing the number of times a certain riprap failure mode was recorded by each District. Table D1 (pages D8, D19 and D30) contains the details used to develop Figure 9.

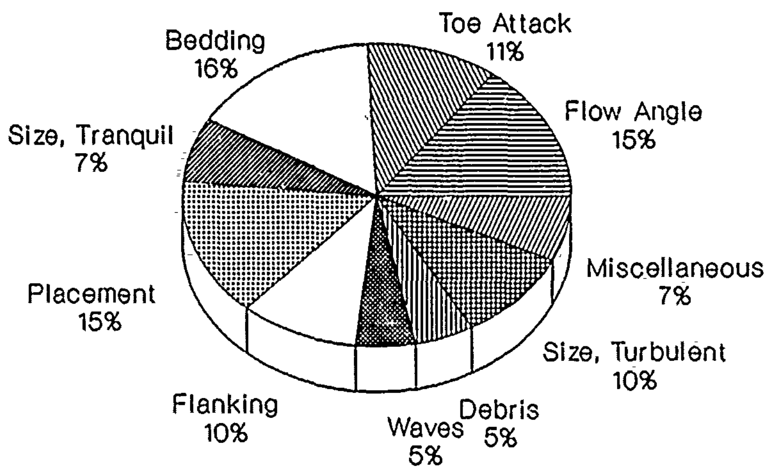

Figure 9. Riprap failure causes

46. As indicated in Figure 9, four of the leading causes of riprap blanket failure are poor bedding, angled flow attack, stone size, and poor placement procedures. Failures due to riprap stone size were divided into two subcategories, i.e., "Size, Tranquil" and "Size, Turbulent," in Figure 9 to reflect failure causes based on flow classification. Low turbulence failures would tend to be boundary shear generated, while high turbulence failures would tend to be caused by excessive turbulent forces generated by abrupt changes in channel geometry or boundaries. Descriptions of three of the main causes of riprap failure follow:

a. Poor bedding. Bedding failure refers to bank sloughing, seepage failures, fabric problems (sliding, clogging, tearing), granular filter problems, and any other foundation failure problems.

b. Angled flow attack. Flow angle refers to a high velocity of flow concentrated on a particular bank location. This can be caused, for example, by meandering or braiding, alternate bars, or obstructions. Toe attack is a closely related phenomenon.

c. Poor placement procedures. Poor placement refers to proper gradations either not available or not used, poor stone quality (i.e., shape, ability to withstand weathering), stone segregation, and/or poor maintenance.

47. Other methods used. Several Districts have their own methods for riprap stone sizing and/or grading. This, they indicated, is due to dissatisfaction with general sizing and gradation guidance. Their methods range from those provided by other agencies to primarily empirical methods. Table D1 (pages D9, D20, and D31) presents some details on these methods.

48. Related research and guidance needs. Figure 10 summarizes the most commonly mentioned riprap research or guidance needs from Table D1 (pages D9, D20, and D31). (Note: WES has developed much improved general riprap design

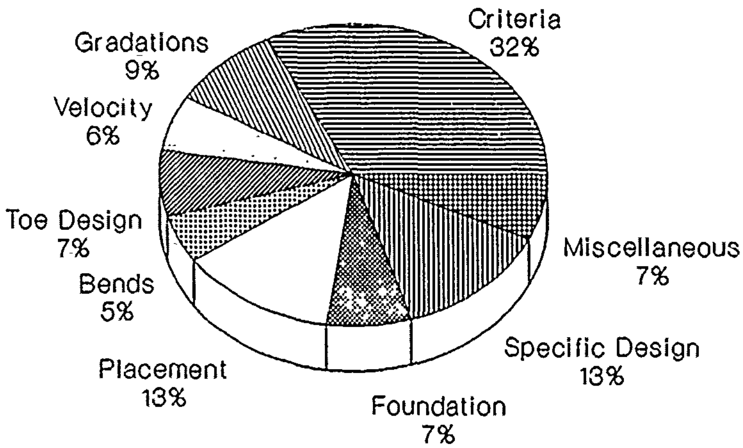

Figure 10. Riprap design criteria needs

guidance and criteria since the inventory reported herein was completed.) The two most commonly heard criticisms concerned the perceived inadequacy of riprap design guidelines, in general, and the overconservatism of gradation requirements, in particular. All other topics are, in essence, subsets of these two. Further discussion of needs for improved design guidance led to the following:

a. The most often mentioned and acutely felt need is for a comprehensive riprap design manual covering all aspects of design and every situation. Several coastal Districts stated that design guidelines presented in various publications are not compatible. Every District felt that adequate guidance did not exist for transition design; design for higher velocity channels, such as mountain streams; riprap above and below a structure; stone quality criteria; foundation considerations; use and design of filters; placement methods; riprap in bends and braided streams; riprap and levees; stable toe design including depth of scour estimates; and use of grout to reduce riprap size in turbulent flow conditions. Districts also need to know the areas for which adequate design guidance is not available and what is being done about it.

b. Current design guidelines are often suspect. Specifically, (1) the riprap sizing method presented in EM 1110-2-1601 (HQUSACE 1970) was often cited as not providing reasonable answers for shallow, small, or rapidly flowing streams. This method will actually not converge on an answer at all for some real-world situations. (2) Additionally, many Districts are confused about which design methods and safety factors to use. A simple, easy-to-visualize method is needed. (3) A better definition of pertinent stream velocities and how to accurately measure or estimate velocities is urgently needed. (4) Several Districts stated that, although they agreed that boundary shear concepts are applicable, shear is not possible to measure and should be converted to an applicable velocity that could be measured or estimated. Several existing District methods do this.

c. Many felt the gradation specifications or method for determining gradations is overly conservative and unrealistic. The present methods require narrow and multiple gradations that drive project costs up or are unattainable at any price for many small projects. Some suggested a standard riprap gradation, or the gradation approved by the state in which they operate, be permitted in Corps specifications.

49. There were a number of questions asked about design situations and placement methods. One request was for documentation of different stream modification techniques, such as Iowa vanes and Gobimat. There was a general feeling that the findings of the Section 32 Program were never fully explored for possible applications. Section 603 of the WRDA authorizes additional streambank erosion control projects with a 25 percent non-Federal cost-sharing provision. This may provide an opportunity to further evaluate and test promising methods introduced under the Section 32 Program. The following is included to help clarify Figure 10:

a. "Placement" refers to questions concerning use of filter fabric beneath riprap, underwater emplacement methods, lateral extent of riprap, stone specifications, quality control, and various construction techniques.

b. "Specific Design" refers to a variety of riprap design information needs relative to specific project conditions. These include boat propeller wash, effects of vegetation, ice attack, sizing near structures, and sizing in and around groins and dikes.

c. "Miscellaneous" topics of concern are (1) a better definition of angled flow forces and sizing criteria for them; (2) a way to design for bends that uses the actual thalweg shape and not the channel shape; (3) handling foundation failure problems; (4) toe design for all cases; (5) transition design; and (6) miscellaneous other topics given in Table D1 (Pages D9, D20, and D31).

Grade control

50. General comments. A wide variety of grade control designs and experiences exist within the Corps. The Vicksburg District continues to construct more grade control structures than any other District. The Missouri River, South Pacific, and North Pacific Divisions also have extensive experience in grade control structure design. All Districts with an abundance of alluvial streams have had some experience with drops, sills, weirs, or some other form of grade control. A number of local methods are used for spacing and drop height design, although every District confirmed the need for research in this area. Some designs are driven by cost limitations, some by hydraulics. The "bottom line" feeling is that the "unknowns" in grade control design greatly outweigh the "knowns."

51. Research needs. All needed grade control research could be categorized under "Comprehensive Criteria." However, the other needs, as summarized from Appendix D, are also shown in Figure 11. The category "Comprehensive Criteria" includes (a) design of low-cost structures, (b) sedimentation analysis, (c) local scour analysis, (d) stable slope determination, and (e) how to attain a stable slope with spacing and drop.

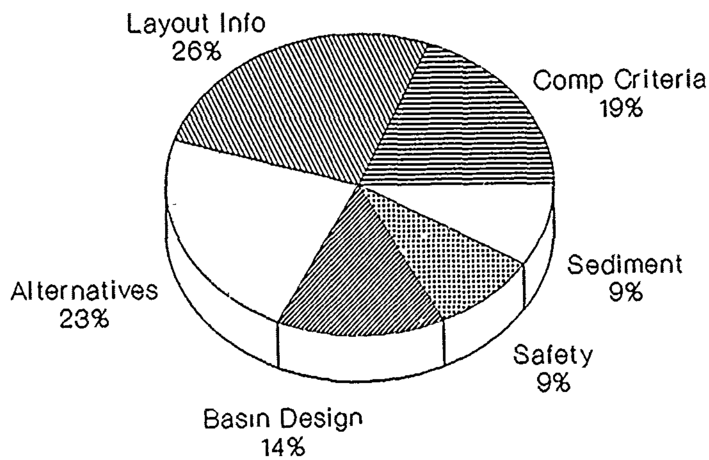

Figure 11. Grade control research needs (see detailed needs in Appendix D and explanation in paragraph 51)

52. Considering the direction of the comments as a whole, a comprehensive and coordinated research program for the improvement of grade control structures was suggested. The suggested program includes the following:

a. A comprehensive literature search including all aspects of grade control design. The literature search would serve as a basis for determining the other research tasks.

b. Data collection from specific sources including the Vicksburg District's Demonstration Erosion Control (DEC) project in the Yazoo Basin, Los Angeles District projects, and Missouri River Division's Gering Valley.

c. Physical model studies adjusted to the prototype data. This would allow different boundary and configuration conditions to be quickly evaluated.

d. An assessment of new or potential materials and techniques, such as gabions and grouted riprap.

e. Mathematical model studies verified to both prototype and physical model results. This would allow the generation of a wide range of data for possible development of design charts, nomographs, and other relationships.

f. Initiation of additional demonstration studies, such as the DEC program.

Environmental

53. General comments. Concern for the environment has become a major design consideration of all Districts. However, many feel that environmental concerns are not being addressed in an efficient or timely manner.

54. Some specific District comments follow:

a. Concern for the environment, although important, has not always fit easily into a design procedure or actual design. Fortunately, Sections 906-908 of the WRDA provide for mitigation areas to be set aside prior to or concurrent with land acquisition for construction, and a mitigation fund of $35 million per year. In addition, the WRDA redefines benefit/cost procedures for environmental quality measures. Section 924 of the act establishes an Office of Environmental Policy in the Civil Works Directorate to oversee various environmental activities.

b. Environmental features are often not compatible with the hydraulics of a project (e.g., low-flow channels in a heavy bed-load stream, boulders just off the apron of a stilling basin, alternate bars in a stream that has just been excavated and has questionable planform stability). In addition, environmental features are sometimes incorporated too late for maximum benefits to be derived.

c. More coordination should take place between the Corps and other agencies and special interest groups early in the planning stage. Such action would help prevent objections by environmental groups from occurring late in the design process and the possible need to provide for add-on environmental features.

d. The smooth coordination of environmental concerns is most often a function of the personalities of the parties involved. Some stated that the perceived controversies between the Corps and environmental groups could be avoided through extra effort and understanding, if communication was established early in the planning phase.

e. Little is known about the effects of certain environmental design features on the viability of hydraulic structures (e.g., vegetation effects on riprap, meander cutoffs left partially open, notches in drop structures, boulders in an unstable stream, one-sided channel clearing).

f. Often the costs of environmental features are unreasonable compared to the benefits of the project as a whole, and local sponsors are not willing to bear that financial burden. Maintenance of environmental features is too often neglected, defeating the very purpose of the structure and harming the flood-control project.

55. Design features. The environmental design features and considerations depicted in Figure 12 are a compilation of what has either been recommended or already built by the Corps. (See Table D1, pages D12, D23, and D34, for a more detailed breakdown.) Numerous publications describing the consideration of environmental features in flood-control channels and related designs are available from the WES Environmental Laboratory (EL), which has completed a comprehensive survey of environmental features included in Corps projects.

56. Descriptions of the major environmental features included in Figure 12 are as follows:

a. "Vegetation" includes both the preservation of certain vegetation along streams or in overbank locations as well as revegetation or vegetation establishment efforts.

b. "Construction Timing" refers to the limitation of construction activities to certain times of the year (e.g., before or after spawning of salmon or other seasonal windows).

c. "Construction Limits" refer to the limitation of the horizontal or vertical extent of a project (e.g., reserved wetland areas, dredged material disposal limit along channel widening on one side only, and overbank excavation only), and limitations on use of certain materials (such as use of riprap only, stone of a certain pH).

d. "Shape Modifications" include the construction of low-flow or

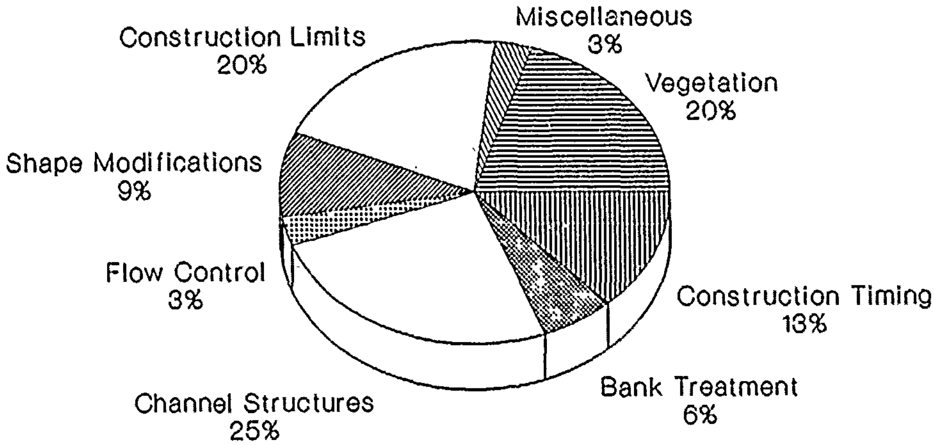

Figure 12. Environmental features

pilot channels, certain channel shapes, and pool and riffle or meander maintenance.

e. "Channel Structures" refer to a variety of structures designed to enhance the environment, from those which facilitate fish breeding and passage to those which have primarily aesthetic purpose.

Operations and Maintenance

57. General comments. Project performance should be periodically assessed to determine the validity and accuracy of approved design and construction techniques and the need for O&M. This is particularly true for channels in which sediment transport plays a major role. Unfortunately, not very many personnel with O&M experience attended the meetings held in conjunction with this inventory. One noteworthy shortcoming of the design process is that there is often not enough time or resources for the designers themselves to field-inspect periodically the postconstruction performance of numerous small projects.

58. Specific comments. The comments recorded here came primarily from the perspective of designers, rather than O&M personnel. Many Districts gave few or no answers to this set of questions.

59. By far the most common method for estimating O&M requirements was given as "experience" or "judgment." Other reported ways of O&M estimating included percent of first cost, comparison with similar projects, and how much money the locals could reasonably afford to spend. The "percent of first cost" method may not be applicable because sometimes the more money a project costs, the less the maintenance it requires.

60. The general consensus is that O&M requires better procedures for cost estimation, more feedback, and a better enforcement program. The following specific comments are common to a number of Districts:

a. Funding has not kept pace with project deterioration, thus allowing many projects to fall into a state of disrepair.

b. There is little feedback from O&M or inspection reports to the designers. Designers usually do not have the opportunity to go on field inspections, and thus have little knowledge of the success or failure of their projects. Several engineers stated they probably make the same mistakes over and over again due to the lack of corrective feedback. One District used this stream inventory effort to justify comprehensive field inspections, which were found to be very enlightening.

c. The maintainability of a project is often not given sufficient consideration during design. Some designers expressed a need to receive training on maintainability as a design consideration.

d. Often, inspections are done by individuals not sufficiently trained to recognize current or potential stability-related problems or are not sufficiently funded to enable spending the time necessary to analyze potential problems and to formulate reasonable solutions. Several Districts suggested that a course for inspectors be developed or that designers be trained in inspection procedures. An inspection checklist and guide for local flood protection projects exists (HQUSACE 1973), but is often not employed.

e. Sediment-related O&M estimates are very difficult to make, and often little data are available. Guidance is needed.

f. Many projects have become ineffective due to lack of maintenance. Well-maintained projects are the exception rather than the rule. Preventive maintenance is often not done. There seem to be no "teeth" in the rules for enforcing maintenance agreements after a project is turned over to locals. Existing enforcement methods are apparently not seen as effective. Provisions in Section 402 of the WRDA, requiring compliance with floodplain management programs, may have a beneficial impact on this situation.

g. Often, insufficient guidance is given to local sponsors on their expected maintenance costs and procedures.

h. Several Districts felt they had a good "handle" on the O&M issue. These Districts' programs typically include team inspections of some projects, review of inspection reports, some type of data base, and more realistic estimates of O&M costs.

Project review

61. General comments. Early in the pilot study, the subject of the project review process became an issue. Questions concerning the process were

asked in an attempt to identify problem areas. The responses revealed the most common reviewer comments: (a) insufficient project documentation details and (b) inadequate consideration of alternatives. The most common comment by the District project engineers was that reviewers require unrealistic amounts of detail or consideration of alternatives in view of the time and funding constraints for relatively small projects.

62. Other comments by Districts on the project review process include the following:

a. The review process takes too long. Often, when the review comes back, reanalysis must be done to update the hydrology or the local momentum is lost and the local sponsors will no longer support the project. New cost-sharing requirements, emphasis on expeditious design-to-construction times, and District uniformity in procedures mandated by the WRDA may improve this situation. The WRDA also provides for an in-depth study of Corps capabilities to expedite project planning and construction.

b. Redesigning projects after review is expensive. Specific design and reporting requirements are not sufficiently documented in advance (e.g., sensitivity analysis, roughness coefficients, or levee freeboard guidance). Known design and reporting requirements are often unrealistic in view of time and funding constraints (e.g., interior drainage design procedures).

c. Review of some types of small projects should be delegated to a lower level (e.g., Section 14 projects).

d. Innovative or new designs are discouraged. Designers felt they were often limited to using riprap for projects when some other less expensive bank protection method would also work.

e. Designers are confused about what information contained in the manuals should be considered as suggested "guidance" and what should be considered as mandatory design "criteria," e.g., different riprap design procedures and safety factors. The manuals should make a clear distinction between the suggested procedures and the rules that must be followed for project approval by reviewers.

f. Many reviewers' comments are very subjective, i.e., the reviewer's opinion against that of the District's. Several Districts felt that they had more experience than the reviewers in certain areas, but were not given the freedom to use their engineering judgment.

63. Specific comments. The most common reviewer comments on reports prepared by the Districts are shown in Figure 13. The major categories in Figure 13 are explained as follows:

a. "Outdated" refers to the use of methods or material that have

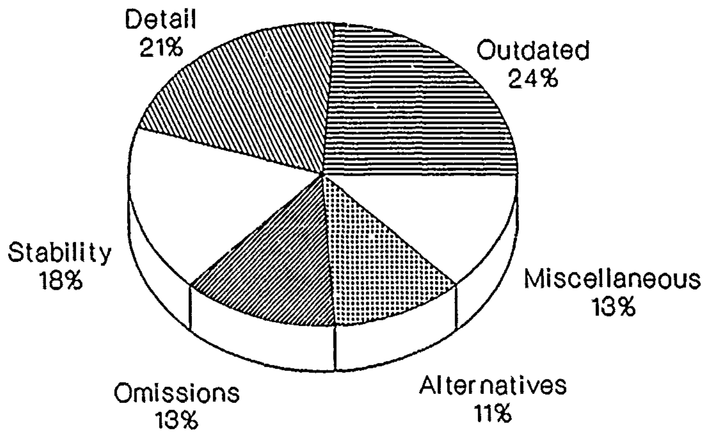

Figure 13. Comments from report reviewers

been superseded by new materials. New design manuals and other guidelines all too often do not reach the individuals who need them most.

b. "Detail" refers to a review comment indicating a need for more detailed information on one or more project features.

c. "Stability" refers to the lack of suitable or appropriate analysis of a stream's postproject stability.

64. Appendix F summarizes some of the most common HQUSACE review comments.

Specific Streams

65. Every potential stream of interest was initially recorded on a form similar to the one shown in Appendix A. Some of these streams were then selected for this inventory and further study. The selected streams are listed in Appendix G and discussed further in the remainder of this report. Reasons for selecting particular streams for further study included (a) good example of a successful design method, (b) an example of a stream that adversely responded to modifications, or (c) a stream on which sufficient data for analysis were available.

66. The 127 different streams selected for further study were partitioned by stream type as shown in Table 3. As indicated in the table, S2- and S3-type streams were the most numerous by subtype. The mixed-load (M) stream type was the largest major group at 37.79 percent. The inventory indicated that further study is most urgently needed for M2- and M3-type sand bed, mixed-load streams (meandering with point bar development and movement), these types of streams being of greatest concern to most Districts.

PART V: ANALYSIS

Promising Design Techniques

67. As indicated earlier, this inventory was concerned primarily with the design and analysis of stable flood-control channels in natural materials. Other topics were addressed incidental to that focal topic. Design techniques for ancillary channel features have been addressed under headings such as "Riprap Design." Various design techniques and experiences, many of which may be unique to a specific District or Division, are noted in Appendix E. This part of the report briefly discusses noteworthy design information or techniques used or suggested by various Districts or on which more information is desired.

68. The most interesting techniques and experiences, together with references or sources of information, are mentioned in the following paragraphs. This list is certainly not exhaustive but it does reflect both the current state of design in the Corps and prospective directions to explore. No attempt has been made in this study to develop a comprehensive list of pertinent references. The WES Hydraulics Laboratory and/or the Districts mentioned can provide further information on request. Many of the methods identified have been applied on a limited basis with some success, but remain unproven for a wide range of applications (or have the range limits defined).

a. The assessment of ways to approach flood-control channel improvement projects needs a framework for identifying various levels of analysis. Figure 14 (Ingram 1987) shows one approach to analyzing proposed alternatives. Another example is the detailed multilevel analysis technique developed by Simons, Li, and Associates (1982). Others have developed their own field and/or office assessment methods. Examples are those developed by Schmidgall in Southwest Division, Harrison and Mellema in Missouri River Division, and Spoor in Ohio River Division.

b. A number of fairly well-known qualitative relationships were mentioned throughout the course of the inventory. Some of the most popular were those by Lane (1955), Simons and Senturk (1977), Schumm (1977, 1980), Bettess and White (1983), and Leopold and Wolman (1957). These serve as tools to aid in the initial assessment of project alternatives and possible impacts regarding channel response.

c. The Soil Conservation Service publication Technical Release (TR) 25 (1977) was mentioned by several Districts. It contains direction on how to employ tractive stress analysis, tractive power analysis, and a modified regime approach, together with

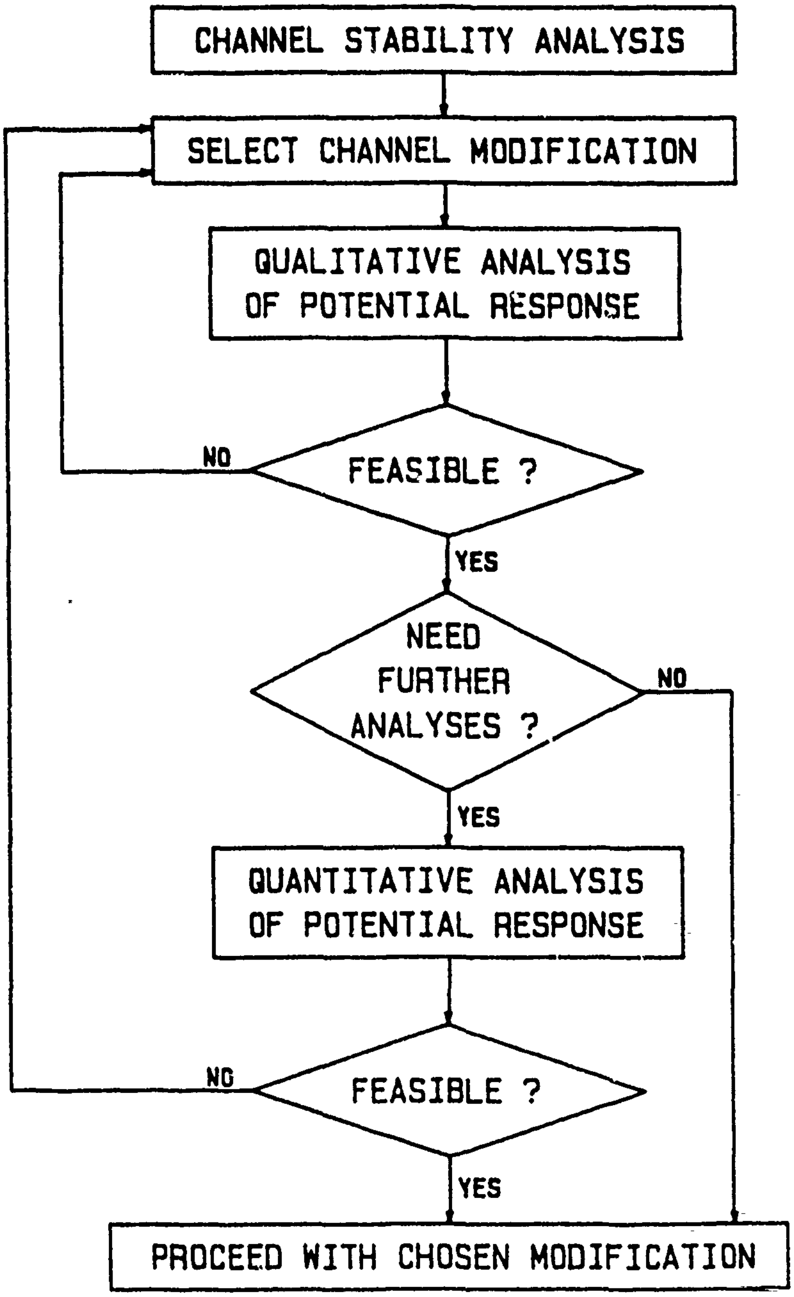

Figure 14. Partial flood-control channel design study plan (from Ingram 1987)

instructions on how to make estimates of sediment transport impacts on channel stability. Most Districts who used this publication highly recommended it. Many of the methods in TR 25, including permissible velocity approach, have been computerized and are available in CORPS program number H0941, "Stable Channel Design From Five Methods."*

d. Neill (Northwest Hydraulic Consultants 1984) has developed a modified regime approach that has been applied to a number of gravel stream data sets and several streams nationwide. It shows good promise and should be further tested. Another option is to develop similar regime equations or coefficients for the current relations for each stream type and/or geographical area. This would require a massive data collection effort.

e. A sediment budget type approach is suggested in EM 1110-2-4000 (HQUSACE 1989). Flow and sediment duration curves are calculated for a specific project site, sediment yield is estimated using an approved method (Dyhouse 1986), and project impact is then assessed. Sediment budget has been used by several Districts for such estimation (Sing 1986). This method has the advantage of being directly related to the hydraulics of the site and is not as dependent on empirical relations.

f. Several Districts have demonstrated the use of limited data in a sediment analysis. For example, one report from the Memphis District demonstrates this type of flexible use of available data.**

g The Vicksburg District and Water Engineering and Technology, Inc. (1989), have developed a systems approach to watershed analysis. The approach was developed for watersheds in the Yazoo River Basin, but it has potential application to other watersheds. The main function of the approach is to assist in the rehabilitation of incised channels, although new flood-control channels may also be designed with the approach. Historical data, field investigations, geotechnical investigations, geomorphic analyses, and hydrologic/hydraulic analyses are all incorporated in the approach. Through the analysis and synthesis of the data, stability parameters, both hydraulic and geotechnical, are developed for channel reaches that exhibit a state of dynamic equilibrium. The parameters are applied to the remainder of the watershed to determine the relative stability of the channel bed and banks. This provides a rational basis for development of rehabilitative measures. Two levels of approach application are possible: a level that is computationally simplistic yet helpful in planning studies, and a

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* This computer program is available from the Engineering Computer Programs Library, Customer Assistance Group, Information Technology Laboratory, WES.

** US Army Engineer District, Memphis. 1985 (22 Jan). "Engineering Analysis of Sanding Damages and Induced Flooding Along Upper St. Francis River, Arkansas," LMMED-H, Letter Report to Mississippi River Commission, Vicksburg, MS.

level that is more computationally intensive and useful during the design phase of a project.

h. Smith (1977) presented a semiempirical approach that shows promise. It involves a type of sediment balance using the Colby transport function. It is applicable for sand sizes between 0.1 and 0.4 mm. Griffiths (1983) has also presented a similar approach and has defined a stability index to assess stream stability.

i. Jackson and van Haveren (1984) provided an example of a combination of geomorphic, hydraulic, and hydrologic principles applied for preliminary stability assessment. This type of hybrid analysis also shows promise.

j. Because most Corps engineers are familiar with the use of HEC-2, it has been suggested that a sediment transport routine be added to it. The data required would necessarily have to be easier to obtain than the data required for HEC-6. A number of simple transport relations are available on the CORPS system. (Note: HEC continues to expand the capability of HEC-2 for use in hydraulic design. Users should check with HEC to obtain the latest version of this program.)

k. A report by Robbins and Simon (1983) detailed the impact of man-induced changes on west Tennessee tributaries. Several analytical methods were developed to analyze these streams. These tools can predict rate of channel adjustment propagation along a stream, using a combination of stream power concepts and functions of slope and time. These predictive capabilities show promise of extension to other areas. (Note: The Lower Mississippi Valley Division indicated that they do not subscribe to the design techniques reported by Robbins and Simon. The Memphis District elaborated on the reasons for this by stating that the empirical relationships were developed from streams in the West Tennessee Tributaries Project, where improvements were stopped by court injunction and not completed as designed. This resulted in unusual circumstances and stream responses that are not representative of the responses expected of a drainage system subjected to channel improvements. In analyzing bridge impacts, not all pertinent factors were addressed to the appropriate level in the report. Thus, the conclusions regarding bridge impacts are not supported by the data presented.)

l. Several graphical methods of stable channel design also show promise. Chien (1955a) uses the Einstein bed-load function to develop nomographs that depict slope and depth required to conduct a specified flow and sediment load. Chang (1985a) presents a graphical method using the stream power approach for canal design for distributary systems.

m. Stability analysis of coarse alluvial channels is discussed in several articles from Colorado State University, Fort Collins, CO. (Simons and Hamilton 1969 and Bhowmik and Simons 1969). These procedures should be checked against applicable streams.

n. A channel "in regime" is defined as having no net erosion or deposition over a flow cycle. A myriad of regime-type relations exist. Several have been mentioned previously. Several Districts and other Corps staff personnel suggested that a data base be created so that a number of the most promising regime relations could be tested, new relations created, and coefficients defined. Mueller and Dardeau (in preparation), as well as several textbooks, provide in-depth overviews of regime methods. Henderson (1963) and Chien (1955b) provide insightful analysis.

o. The San Francisco District has developed a method for stability analysis using Froude number concepts that may be useful in other applications.

p. Several computerized models have been developed recently that deal with various aspects of channel stability. Chang (1985b) has developed a model that predicts scour in a bend for a single storm or a series of storms (used in Southwest Division). Odgaard has developed a model that predicts scour and bed shape using simple data input (Odgaard 1986a, 1986b). Parker developed a model that predicts planform deformation over time (used in the Buffalo District on Mt. Morris Dam). Osman and Thorne (1988) have a new model that predicts bank erosion and stability (scheduled for use in the Vicksburg District). These new models, and others, should be tested against prototype data. Data collection programs should be instituted under research programs.

q. Other approaches to explore include historical analysis procedures, aerial photo interpretation, and sediment study or field inspection procedures and checklists (such as those available in the Southwest and Missouri River Divisions and the San Francisco District).

r. The use of "expert" systems for analysis of stable channels may be practical in the future. In this case an analysis system could be programmed to lead the designer through logical consideration of all stability-related factors that may impact the design, including analysis. Expert systems have been applied in other areas of water resources with favorable results (James and Dunn 1985).

Inventory Approach

69. Results of this inventory revealed that an approach to stable channel design is needed as much as the design tools themselves. Several HQUSACE publications contain guidelines on stable channel analysis reporting (HQUSACE 1978, 1982a, 1984). However, additional guidance is needed (with input from the documents mentioned in paragraph 68) that would help a designer quickly answer the following questions:

a. Do I have a problem? What is the nature of the problem?

b. How do I determine what data are needed to analyze this problem? Where does it come from?

c. How do I perform preliminary analyses? What is my degree of accuracy? How do I know when my design may cause adverse stream response? What are some ways to look at the whole system interaction? What should I do in the office? What should I do in the field?

d. How do I determine if I need to perform more detailed analyses? What type?

e. What guidance should I give for O&M estimates? How do I develop it? How do I design for maintainability?

Stream Type Versus Modification Type Correlation

70. One objective of the inventory was to match successful design types to stream types. A number of different ways to analyze and depict the stream type versus modification type information were tried but most proved misleading or not significant. A variation of a matrix organization approach involving functional uses of water and functions served by research, developed by Warman and Joiner (1974) and implemented by Vertrees (1985), was employed with little success to help identify trends.

71. The decision was then made to display the data by plotting a matrix of stream type versus modification type for each Division area and for all areas in combination. Tables D3 through D14 (pages D46 through D57) depict this correlation of stream type to modification type. A total of over 2,000 combinations of stream and modification were plotted. Table D14 summarizes the data via percentages for easy comparison.

72. While the variation of individual totals would certainly be statistically significant, there is, of course, no assurance that the differences are meaningful and accurate. In other words, there is a good chance that outside variables may have a negative impact on survey statistics for the following reasons:

a. Reasons for choosing a certain design type were as much influenced by habit, politics, environmental concerns, budget constraints, reviewer preferences, or other nonhydraulic factors as by pure hydraulic analysis.

b. Individuals in attendance at some of the meetings did not possess sufficient knowledge of project performance to give an accurate picture. Individuals often stressed their own areas of interest or familiarity, thus giving them exaggerated weight. The designers were generally not on the inspection teams. In addition, inspection reports rarely made it back to the designer's office or were too incomplete, from a hydraulic standpoint, to give much insight.

c. A number of Section 14 (Public Law 526) and other relatively small projects were not specifically mentioned, nor were exhaustive lists of such projects procured and added to the project totals. These type projects make up a large percent of the total effort now underway in the Corps.

d. Many of the projects have never been tested at flows approaching design conditions. Thus, the viability of their designs is unknown.

73. Site-specific or somewhat unique problems accounted for a large percentage of the failures (e.g., bank sloughing, improper placement of stone, poor maintenance, flow angle). This inherent fact tends to complicate the analysis of successful and unsuccessful design methodology.

74. For example, grade control structures have been used quite successfully on many different type streams. However, there have also been problems and failures involving most stream types, and for widely varying reasons. An M2-type stream in north Mississippi may, for example, respond favorably to toe protection, whereas a similar stream in Minnesota may not. The reason for this may be the differences in flow characteristics and bank material. Different vegetative cover and climatic conditions at the two sites may also play a part.

75. Thus, one cannot always accurately determine which design(s) will undoubtedly be successful for a certain stream type. Streams are too individualistic. To differentiate stream types to the degree of detail necessary would be, in a sense, to regionalize the data for each watershed or even for each reach within a watershed.

76. The results of this survey were not meant to produce actual design limits or criteria, but only to provide thoughts and direction for further study. The question of which specific designs are successful for particular streams cannot be answered effectively until the more detailed Phase 2 (see paragraph 5) of the stable channel design work unit is completed, as discussed in Part VI.

PART VI: CONCLUSIONS AND RECOMMENDATIONS

General Conclusions

77. This study, of necessity, focused on many negative aspects of the design of stable channels and related topics. This does not mean that design guidance for stable channels in natural materials is totally inadequate. Channel projects that are operating as planned or have not been subjected to high flows recently do not "make the news." The projects that have not caused problems were, therefore, usually not discussed at the meetings. Perhaps the greatest benefits of the inventory were to help define common design problems and to obtain suggestions for solving these problems. In general, the results of this inventory

a. Provide insight into future research and guidance needs for bank protection (particularly riprap), grade control, stable channel design, and flood-control project design criteria in general.

b. Identify problems in the areas of project review, environmental issues, local cooperation, District operations and inspections, design procedures, and project maintenance.

c. Give specific information about streams and promising improvement techniques for future study, centers of expertise for various topics, points of contact for future coordination, design methods used, and stream types existing in each Division.

Specific Conclusions and Recommendations

78. A brief summary of significant conclusions for each aspect of the inventory (as related to the agenda questions in Appendix C and inventory goals in Part I) follow. Initial paragraph references are included for easy cross reference.

a. Division and District points of contact have been identified (Tables 1 and 2). Specific areas of expertise within each District have been identified to some extent (Appendix E). All available Corps expertise should be accessed in much the same way as that of members of the Committee on Channel Stabilization. Knowledge should be shared informally Corps-wide through symposia, computerized bulletin boards, referral lists, or other means.

b. The two most common flood-control channel problems are bank instability and siltation (paragraph 19). Research should concentrate in these areas.

c. The most common stream types, and those that seem to cause the most intense problems, are M2 and M3 streams (paragraph 22). See Appendix A for definition of stream types. Braided streams cause the most problems in the Pacific Northwest and Alaska.

d. Small projects are the primary concern for most, if not all, Districts (paragraph 26). The Corps should, therefore, ensure that recommended design guidelines and criteria are applicable to small projects.

e. The most common design and failure problem in the Corps is bank protection (paragraphs 28 and 33). The use of other alternatives, less expensive methods, and more acceptable methods should be encouraged and research in this area intensified. Commercially available products should be evaluated for potential use, particularly in urban areas where aesthetics are important. Riprap research is of prime importance.

f. Often the choice of which stream improvement method to use is dictated by reasons other than a combination of hydraulic and economic considerations (paragraph 30). Consequently, inferior designs may result. Innovative designs should be encouraged and previous problems explored.

g. Initial funding levels for design were mentioned repeatedly as being insufficient (paragraph 35). Many Districts stated that a larger initial investment in hydrologic or hydraulic studies (including stability analysis) would identify critical factors early on and save time and money in the future. Often the problem was one of allocation of available resources rather than insufficient funds. Numerous suggestions were given.

h. A large and diverse number of design criteria needs were expressed (paragraph 38). Two of these needs were judged most important. The first is a need for comprehensive guidance on streambank protection (including detailed discussion of all aspects of riprap design) and on other alternative methods. The Section 32 Program results should be made more useful a . available (perhaps as an applications design manual). The second need is for a simple way to assess channel stability without the need for masses of data. This could be translated into an analysis procedure, backed up by various techniques, to assess stability issues at each decision point. A multilevel technique is recommended.

i. Districts would also benefit from making greater use of techniques and experiences already available (paragraph 40). However, they are often unaware of available sources of this information (especially at the junior engineer level).

j. Most Districts have expertise in specific areas of hydraulic design (paragraph 41). Many have been identified. The need for cross-communication and coordination is emphasized.

k. There are many causes of riprap failure (paragraph 45). The most urgent riprap research requirements fall into two categories: (1) development of techniques to accurately assess the forces impinging on the stone for all conditions, and

(2) comprehensive guidance covering all aspects of riprap design and placement. The present guidance is seen as fragmented and often suspect for certain design situations (paragraph 48). The effect of long-term exposure on riprap also needs further study.

l. There is a feeling that the unknowns in the proper design of grade control structures (drops, sills, etc.) far outweigh the knowns. Comprehensive research is needed (paragraph 52).

m. It is perceived that environmental concerns are not well integrated into the design of many flood-control projects. Some design guidance exists for considering environmental features. Concerted efforts should be made to establish good relations with all concerned parties well ahead of project plan formulation (paragraph 54).

n. From the designer's perspective, the O&M program is not working well. There is little or no feedback on project performance, little prototype monitoring or performance data, and poor enforcement of maintenance agreements. O&M estimates are often made on a faulty basis because adequate guidance and data do not exist or are not used (paragraphs 59 and 60). A number of suggestions are given to help alleviate this acute problem. One noteworthy suggestion was for design engineers to periodically inspect their projects during and following construction.

o. Districts feel that reviewers require unrealistic amounts of detailed information, given the time and money constraints on small projects (paragraph 61). A streamlined review process should be implemented for small projects. The elapsed time from project conception to construction is too long. Project costs are increased as the result of excessive design and construction requirements and review involvement. A number of specific recommendations are given.

p. Appendix G gives a list of specific streams identified for further study. S2- and S3- and M2- and M3-type streams were mentioned most often and are recommended for priority study (paragraph 66. (See Appendix A for definitions of stream types.)

q. A large number of promising design techniques for various aspects of stable channel analysis are mentioned (paragraph 68). These techniques must be integrated into an analysis structure or procedure. One of the most notable is HEC-2, with enhancements such as sediment subroutines, modified regime approaches, various types of geomorphic studies, and simple sediment budget approaches.

r. The correlation of successful design types with stream types was hampered by a number of factors (paragraph 72). However, a basis was laid and recommendations made for further research in this area.

Stable Flood-Control Channel Research Recommendations

79. With input from this inventory, the next phase of the investigation into stable channel design and analysis might proceed along the following lines:

a. Selection of the most common stream types has been completed. From Table D13 (Page D56), the alluvial streams that nationwide are encountered most commonly and cause the greatest concern are the M2 and M3 meandering types. S2- and S3-type streams are a close second.

b. The most successful design techniques applied to these particular type streams should be investigated method by method. The investigation should (1) focus on uncovering the actual critical design parameters and specific reasons for failure (and for success) of sites; (2) determine if existing design criteria are defective, not applicable, or improperly applied, or whether failures were the result of such factors as inadequate maintenance and events exceeding design flows; (3) then, proceed from specific site studies to a generalization of design criteria; (4) include theoretical as well as empirical approaches to design; (5) place emphasis also on recognizing those factors that can greatly impact a particular design but are not commonly found throughout the country (i.e., site-specific factors).

c. This investigation should include (1) data collection at field and office sites, including scour data, historical analysis and prototype evaluation, and monitoring involving District design personnel; (2) literature searches to uncover variations in design and analysis techniques; (3) extensive discussions with appropriate District personnel; (4) demonstration projects; (5) laboratory experimental, model, or basic theoretical studies to identify controlling parameters; (6) interagency symposia similar to the stream meandering symposium held in New Orleans in 1983; and (7) the application of alternative design techniques to situations for which the outcome is known to test validity.

d. Research funding should be carefully coordinated and goals and products identified in detail.

80. The original intent of this inventory was simply to gather some information on the design of stable flood-control channels. With time and the involvement of persons with varied interests, the inventory expanded to cover a wide range of topics more or less related to the original intent. Any good research program requires coordination, communication, and understanding from all sectors directly or indirectly involved or influenced by the findings. Visionary direction and adequate funding are required from top management.

Effective supervision and review are needed from middle management. Common understanding and concerted effort from researchers and practitioners are essential. Hopefully, the results of this study will point Corps researchers and hydraulic design engineers toward thoughtful reflection, positive change of direction (as appropriate), and appropriate action in developing a coordinated research, design, and management program for stable flood-control channels in natural materials.

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Table 1

Points of Contact at WES and in the Corps of Engineers Divisions

Name*	Office Symbol	Commercial Telephone
Tony Thomas	CEWES-HR	601-634-2511
Estes Walker	CELMV-ED-W	601-634-5914
(Larry Echenrod)	(CELMV-ED-WH)	(601-634-5917)
Warren Mellema	CEMRD-ED-TH	402-221-7323
Andy Petallides	CENAD-EN-TH	212-264-7459
Jose Ordonez	CENCD-ED-TM	312-353-9057
Chuck Wener	CENED-ED-W	617-647-8686
John Oliver	CENPD-EN-TE	503-326-3859
Glen Drummond	CEORD-ED-TH	513-684-3035
(Lyn Richardson)	(CEORD-ED-WD)	(513-684-3035)
Ted Abeln	CESAD-EN-TH	404-331-6705
(Bert Holler)	(CESAD-EN-HH)	(415-556-4260)
Dick DiBuono	CESPD-ED-W	415-556-5709
(Surya Bhamidipaty)	(CESPD-ED-W)	(415-556-6210)
Tasso Schmidgall	CESWD-ED-WA	214-767-2359

* The postinventory replacement contact is shown in parentheses underneath the name of the point of contact at the time of the inventory.

Table 2

Points of Contact in the Corps of Engineers Districts

District	Name*	Commercial Telephone
Alaska	Carl Stormer	907-753-2741
Albuquerque	Paul Mann (David Gregory)	505-766-2637 (505-766-3225)
Baltimore	Dennis Seibel	301-962-4840
Buffalo	Tom Wilkenson	716-876-2168
Charleston	Robert Billue (Bob Occhipinti)	803-724-4236 (803-724-4678)
Chicago	Tom Fogarty	312-353-8884
Detroit	John Karpis (Bruce Holbrook)	313-226-4886 (313-226-4886)
Fort Worth	Ron Turner	817-334-2222
Galveston	Roy Different	409-766-6110
Huntington	Ken Harman	304-529-5606
Jacksonville	Noble Enge (Henry Anderson)	904-791-1108 (904-791-2106)
Kansas City	Walt Linder	816-426-3854
Little Rock	Gist Wilber	501-378-5541
Los Angeles	Joe Evelyn (Brian Tracy)	213-894-5520 (213-894-5524)
Louisville	David Beatty	502-582-5648
Memphis	Guy Forney (Dewey Jones)	901-521-3391 (901-521-3391)
Mobile	Wayne Odom	205-690-2716
Nashville	Hank Phillips	615-736-5948
New Orleans	Billy Garrett	504-862-2442
New York	Bob Alpern	212-264-9083
Norfolk	Jim Robinson (Larry Holland)	804-441-3774 (804-441-7771)
Omaha	Tim Temeyer	402-221-4611

(Continued)

* Postsurvey replacements are shown in parentheses underneath the name of the original contact.

Table 2 (Concluded)

District	Name	Commercial Telephone
Philadelphia	George Sauls	215-597-6829
Pittsburgh	Robert Schmitt	412-644-6951
Portland	Paul Fredricks (Ted Edmister)	503-326-6486 (503-326-6407)
Rock Island	S. K. Nanda	319-788-6310 ext 310
Sacramento	Mike Nolan	916-551-2101
San Francisco	Bill Brick	415-974-0406
Savannah	Randy Miller	912-944-5456
Seattle	Dick Regan (Jim Lencioni)	206-764-3595 (206-764-3595)
St. Louis	Gary Dyhouse	314-263-5358
St. Paul	Pat Foley	612-220-0630
Tulsa	Tom Horner	918-581-7206
Vicksburg	Jim Ward (Phil Combs)	601-631-5682 (601-631-5682)
Walla Walla	Mark Lindgren	509-522-6518
Wilmington	Max Grimes	919-251-4759

Table 3

Percent of Total by Type of the

127 Selected Streams

Stream Type*		Percent of Total
Suspended Load		
S1		1.57
S2		14.17
S3		14.17
S4		3.15
	Subtotal	33.06
Mixed Load		
M1		2.36
M2		11.02
M3		12.60
M4		8.66
M5		3.15
	Subtotal	37.79
Bed Load		
B1		2.36
B2		4.72
B3		7.09
B4		3.15
	Subtotal	17.32
Other Types		
Delta		0.79
Arroyo		1.57
Unknown		9.44
	Subtotal	11.80

* See Appendix A for definitions of stream types.

APPENDIX A: STREAM TYPES AND IMPROVEMENT METHODS

* COLUMN 3- IMPROVEMENT METHOD

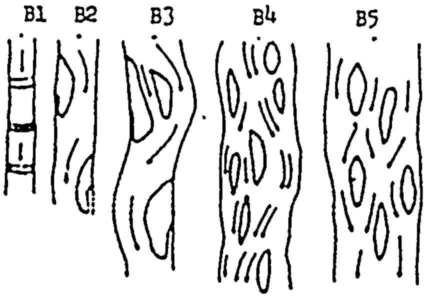
AL-Alignment Change, Relocation
BP-Bank Protection (Give Type)
BM-Basin Modifications
CS-Clearing & Snagging
DB-Debris Basin, Sediment Trap
DI-Diversion Into Channel
DO-Diversion Out Of Channel
DR-Dredging
DE-Deepening Only
EN-General Enlarging
EV-Environmental Features
EX-Selective Excavation

FC-Flow Control, Flood Control Dams
GC-Grade Control, Drops, Weirs (Give Type)
HI-High Flow Channel, Complex Geometry
LV-Levees, Floodwalls, Dikes
PI-Pilot Channels
RE-Recreational Features
RT-Transition Structures/Features
SH-Shortening, Cutoffs, Straightening
SU-Paving, Surfacing, Concrete Channels, etc.
TR-River Training Structures (Dikes, Jacks, et
XC-Auxiliary Channels, New Channel

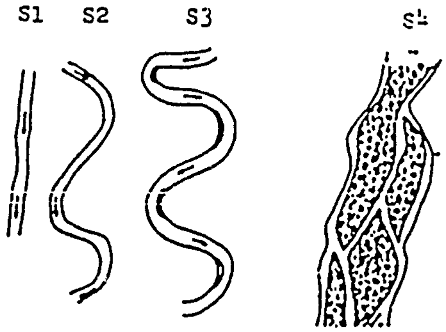
OO-Other (Specify)

COLUMN 4 - STREAM TYPE

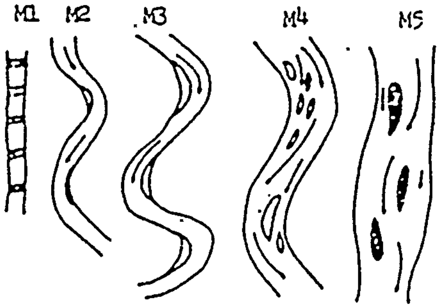
Bedload Streams



Suspended Load Streams



Mixed Load Streams



* COLUMN 5 - BED/BANK MATERIAL

B - Boulders, Cobbles
G - Gravel
S - Sands
F - Fines (Noncohesive)
C - Fines (Cohesive)

* COLUMN 6 - VARIABLES FOR DATA

B-- Bottom Width
T - Topwidth
W - Average Width
L - Length of Improvement
D - Average Depth
V - Average Velocity
S - Bed Slope
DA - Drainage Area
Q_i - Discharge
i = D (Design Flow)
i = # (Return Interval)

* COLUMN 7 - POST CONSTRUCTION DATA

L-- Little S - Some M - Much

* See columns on the accompanying form, page A4.

District: Region Identifier: Sheet ___ of ___ Recorder:

Date:

1	2	3	4	5	6	7	8
Project Name	Date Completed	Improvements	Stream Types(s)	Material (Bed/Bank)	Data (Q, W, Slope, DA)	Post C. Data	Miscellaneous (maint, contact person, etc)

APPENDIX B: STREAM REACH INVENTORY FORM

STREAM REACH INVENTORY FORM SHEET___OF___

(USE DIF COLORED PENS TO RECORD SEVERAL REACHES ON ONE SHEET)

I. LOCATION AND IDENTIFICATION

A. STREAM NAME:______________ PROJ NAME OR ID #:____________

DISTRICT:_____________ STATE OR AREA:________________

ANALYSIS BY:____________________ DATE:_____________

GENERAL LOCATION (ATTACH QUAD SHEET)
FROM:_______TO:________ REACH LENGTH:_________

B. STATE:_____UNALTERED (NATURAL)
_____POST CONSTRUCTION-AS BUILT
_____POST CONSTRUCTION-ADJUSTING OR ADJUSTED
_____POST SUPER FLOOD ADJUSTMENT
_____INDIRECT DUE TO UP OR DOWNSTREAM WORK
_____OTHER (EXPLAIN)

IS THE CHANNEL REACH STABLE (I.E. IN QUASI-EQUILIBRIUM)?_____

C. MAJOR DATA SOURCE(S) AND DATE(S):

D. SHORT HISTORICAL SUMMARY AND PROJECT DESCRIPTION:
(INCLUDE PURPOSE OF WORK,DATES,WORK ACCOMPLISHED,RESULTS,
AND DESCRIBE PROBLEMS IN THE REACH)

II. BASIN CHARACTERISTICS

A. GEOMETRY:

_________ AREA (SQ MI/ACRES)
_________ AVG. OVERLAND SLOPE OF BASIN
____/____ MIN./MAX. ELEVATION (FT-MSL)
____/____ MIN./MAX. OVERLAND SLOPE

B. GEOLOGY/TOPOLOGY

1. TERRAIN (%):

____MOUNTAINS ____FOOTHILLS
____HILLS ____INTERIOR PLAINS/VALLEYS
____UPLANDS ____LOWLANDS/COASTAL
____ OTHER (SPECIFY)______________

2. SURFICIAL GEOLOGY (%):

____BEDROCK ____GLACIO-FLUVIAL DEPOSITS
____GROUND MORAINE ____FLUVIAL DEPOSITS
____HUMMOCKY MORAINE ____AEOLIAN DEPOSITS
____LACUSTRINE DEPOSITS ____OTHER (SPECIFY)_____________

3. MEDIAN DEPTH TO BEDROCK______FT.

4. COMMENT ON SIGNIFICANT FEATURES,TOPOGRAPHIC ANOMALIES, AND EVIDENCE OF TECTONIC ACTIVITY (WHERE APPLICABLE):

C. BASIN SOILS & SEDIMENT YIELD

1. COMMENT ON: (1) BASIN SOILS,(2) KNOWN CONSERVATION PRACTICES, AND (3) PRECENT AREA DRAINED THROUGH RETENTION STRUCTURES.

2. MAJOR SEDIMENT SOURCES (%):

____ BED & BANKS (CAVING,SLUMPING,SLIDING,SCOURING,HEADCUTTING)
____ SHEET & RILL EROSION (CULTIVATED, GRAZING)
____ SHEET & RILL EROSION (NON-CULTIVATED)
____ MASS WASTING & LANDSLIDES (UPLAND)
____ UPLAND HEADCUTTING OR GULLYING
____ CONSTRUCTION (POINT,AREA,LINE)
____ OTHER (SPECIFY)

3. PRIMARY LOADING TYPE:

BEDLOAD___ SUSPENDED LOAD___ WASH LOAD___

SEDIMENT YIELD ESTIMATE _________ TONS/ACRE/YEAR IN WATERSHED

4. COMMENTS ON SIGNIFICANT FEATURES:

D. BASIN VEGETATION/LAND USE (%):

___/___ BARREN (ROCK/DESERT SAND)
____ GRASS
____ SHRUBS
___/___ FORESTED (DECIDUOUS/CONIFEROUS)
____ SWAMP OR MUSKEG
____ PERMAFROST
____ CULTIVATED
____ URBAN (BUILT UP)

E. AREA CLIMATE

1. TYPE:

____ARID (DESERT) ____MOIST SUBHUMID (MIXED)
____SEMIARID (STEPPE) ____DRY SUBHUMID (GRASSLAND)
____HUMID (FOREST) ____SUPER HUMID (RAIN FOREST)
____ARCTIC-SUB ARCTIC ____OTHER (SPECIFY_______________)

2. PRECIPITATION (IN):
_____ PERIOD OF RECORD & LOCATION _____
_____ MEAN ANNUAL (RANGE FROM_______TO_______)
_____ MAX. MONTHLY (MONTH)___________
_____ MIN. MONTHLY (MONTH)___________
_____ DESIGN STORM (DURATION_____, RETURN PERIOD______)
_____ DESIGN STORM (DURATION_____, RETURN PERIOD______)
_____ DESIGN STORM (DURATION_____, RETURN PERIOD______)
_____ OTHER (SPECIFY)_____________
_____ % PRECIPITATION AS SNOWFALL
(ATTACH UNIT HYDROGRAPH IF AVAILABLE)

EVIDENCE OF PROLONGED WET OR DRY PERIODS (PERSISTENCE)?

___ YES ___ NO

3. COMMENT ON INFILTRATION RATES (E.G.. RUNOFF/PRECIPITATION)

___ RUNOFF (IN/YR) _____

4. TEMPERATURE

_____ AVG. ANNUAL (DEG. F)
_____ MAX. MONTHLY (DEG. F) _______ MONTH
_____ MIN. MONTHLY (DEG. F) _______ MONTH
___/___ MIN./MAX. RECORDED (DEG. F)

F. MAN'S WITHIN BASIN INFLUENCE (OTHER THAN ABOVE):

III. VALLEY/VALLEY FLAT/ FLOODPLAIN

A. VALLEY AND CHANNEL VICINITY

1. TYPE:

____ STREAM CUT-NARROW
____ STREAM CUT-WIDE
____ WIDE MOUNTANEOUS
____ ALLUVIAL PLAIN
____ ALLUVIAL FAN
____ DELTA
____ OLD LAKE BED
____ OTHER (SPECIFY_________)

2. TERRACES:

____ NONE
____ INDEFINITE
____ FRAGMENTORY
____ CONTINUOUS
_____ NUMBER OF LEVELS

3. LATERAL CONSTRICTION/CONFINEMENT BY VALLEY WALLS ETC.:

____ NONE
____ LOCAL (GIVE LOCATION AND TYPE)

____ GENERAL ____ % CONFINEMENT LEFT BANK
____ % CONFINEMENT RIGHT BANK

4. FLOODPLAIN DIMENSIONS:

_______ MEAN WIDTH (FT) _____/_____ MIN./MAX. WIDTH (FT)
_______ AVERAGE INUNDATION TIME INTERVAL (YRS.)
_______ AVERAGE DEPTH OF SILT IN FLOODPLAIN (FT)

5. FLOODPLAIN VEGETATION AND LAND USE (%):

___/___ BARREN (ROCK/DESERT)
_______ GRASS
_______ SHRUBS
___/___ FORESTED (DECIDUOUS/CONIFEROUS)
_______ SWAMP OR MUSKEG
_______ PERMI-FROST
_______ CULTIVATED
_______ URBAN (BUILT UP)

B. RELATION TO CHANNEL

1. GENERAL:

IS THE CHANNEL PERCHED ____
INCISED ____
UNDERFIT ____
IF PARTIAL GIVE PERCENT __________

2. NATURAL LEVEES:

____ NONE
____ LEVEES MAINLY ON CONCAVE BANK
____ LEVEES ON BOTH BANKS

3. MANMADE LEVEES:

_______NONE

LOCATIONS:

_______ DISTANCE BETWEEN (FT)
_______ HEIGHT (FT ABOVE BASE)

PERCENT LENGTH ____LEFT BANK ____RIGHT BANK

IV. CHANNEL DESCRIPTION

A. FORM

1. GENERAL:

____ STRAIGHT
____ SINUOUS
____ BRAIDED
____ IRREGULAR (STRUCTURAL CONTROLS)
____ IRREGULAR MEANDERS
____ REGULAR MEANDERS
____ TORTUOUS MEANDERS

IS THIS AN ALLUVIAL CHANNEL? ___ YES ___ NO

IS THE STREAM ____EPHEMERAL____INTERMITTENT ____PERENNIAL

2. MEANDER DIMENSIONS:

Q___ Q___
____/____ BELT WIDTH (MILES) RANGE:
____/____ MEANDER WAVELENGTH (MILES) RANGE:
____/____ SINUOSITY
____/____ C.L. RADIUS OF CURVATURE & RANGE:
____/____ C.L. RAD. OF CURV./TOP WIDTH RATIO
____/____ RANGE OF Rc/Tw

3. ISLANDS:

____ NONE
____ OCCASIONAL
____ FREQUENT
____ SPLIT
____ BRAIDED

4. BAR TYPE (RATE 1,2,3,ETC. IN FREQUENCY):

____ NONE
____ SIDE BARS
____ POINT BARS
____ JUNCTION BARS
____ MID-CHANNEL
____ DIAMOND
____ DIAGONAL
____ SAND WAVES

5. OBSTRUCTIONS:

____ NONE
____ OCCASIONAL MINOR
____ OCCASIONAL MAJOR
____ FREQUENT MINOR
____ FREQUENT MAJOR

TYPE(S):________________________

B. PRIMARY REGIME VARIABLES

1. DISCHARGE (CFS):

______ ______ PERIOD OF RECORD
______ ______ :GAGE LOCATIONS

______ ______BANKFULL (Q__)
______ ______Q1
______ ______Q2
______ ______Q5
______ ______Q10
______ ______Q100
______ ______NORMAL LOW WATER
______ ______STANDARD PROJECT FLOOD
______ ______MEAN OF YEARLY MAXIMUM DISCHARGES
______ ______FLOOD OF RECORD (DATE:_______)
______ ______DESIGN FLOW
______ ______OTHER (SPECIFY_______)

(ATTACH FLOW-FREQUENCY CURVES AND/OR FLOW DURATION CURVES AND STAGE-DISCHARGE CURVES)

2. VELOCITY

Q__ Q__
____ ____ MEAN VELOCITY-FPS (LOCATION______)
____ ____ POINT VELOCITY-FPS (LOC.______)
____ ____ POINT VELOCITY-FPS (LOC.______)

3. MANNING'S N: _____ AVG. IN REACH
_____ AVG. OVERBANK

4. WIDTH: (ATTACH TYPICAL CROSS SECTIONS IF AVAILABLE)

	Q__	Q__	
MEAN TOP WIDTH IN CROSSING	________	________	(FT)
MEAN TOP WIDTH IN BENDWAY	________	________	(FT)

TOPWIDTH RANGE:
CROSSINGS: FROM______(FT) TO______ (FT) FOR Q___
FROM______(FT) TO______ (FT) FOR Q___
BENDS: FROM______(FT) TO______ (FT) FOR Q___
FROM______(FT) TO______ (FT) FOR Q___

Q__ Q__
______ ______ LOCAL TOPWIDTH (FT) LOCATION_____
______ ______ LOCAL BOTTOM WIDTH (FT) LOCATION_____
______ ______ LOCAL MEAN WIDTH (T/B) (FT) LOCATION_____

5. SLOPE: (GIVE LOCATION OF MEASUREMENTS & CONTROL EFFECTS)

Q___ Q___

______ ______ ENERGY SLOPE
______ ______ MEAN WATER SURFACE SLOPE
______ MEAN CHANNEL VALLEY SLOPE
______ MEAN THALWEG SLOPE

COMMENT ON LOCAL VARIATION IN SLOPE:

6. DEPTH (FT):

Q___ Q___

______ ______ TOP BANK TO THALWEG
______ ______ MEAN DEPTH (AREA/AVG. MEAN WIDTH)
______ ______ HYDRAULIC DEPTH (AREA/TOPWIDTH)
______ ______ OTHER (SPECIFY____________)

RANGE FROM:______TO:______ FOR Q___
FROM:______TO:______ FOR Q___

7. SEDIMENT: (SEE ALSO PARA. G BELOW)

A.______d50 (MM)

B. BANK RESISTANCE: ___HIGH ___MEDIUM ___LOW
% SILT & CLAY IN THE BANKS______
BED ______

C. SEDIMENT TRANSPORT: ___HIGH ___MEDIUM ___LOW

D. COHESIVE MATERIALS (IF APPLICABLE):

	STANDARD PENETRATION TEST BLOWS	OR CONSISTENCY
___	<2	VERY SOFT
___	2-4	SOFT
___	4-8	MEDIUM
___	8-15	STIFF
___	15-30	VERY STIFF
___	>30	HARD

C. FLOW (QUALITATIVE)

1. FLOW TYPE: (AT BANKFULL OR __________)

____ UNIFORM W.S. ____ POOL & RIFFLE
____ UNIFORM WITH RAPID ____ TUMBLING FLOW
____ IRREGULAR

2. CONTROLS: (DESCRIBE UNUSUAL EFFECTS)

TYPE:________ LOCATION:__________
TYPE:________ LOCATION:__________

IS FLOW REGULATED? ___ YES ___ NO
DESCRIBE:

DOES ICE BLOCKAGE EFFECT FLOW? ___ YES ___ NO
DESCRIBE: (INCL. ICE EFFECTED HIGH WATER MARKS)

3. TRIBUTARIES/DISTRIBUTARIES:

LOCATION/:________ % OF MAIN CHANNEL FLOW ____
&ELEV ________ AT BANKFULL ____
________ ____

D. LATERAL MOVEMENT

1. TYPE: (GIVE METHOD OF DETERMINATION AND PERIOD OF RECORD INCLUDE MAP OR PHOTO DATES)

____ NOT DETECTABLE
____ D.S. PROGRESSIVE (EVIDENCE OF SCROLLING?_____)
____ MAINLY CUTOFFS (OXBOWS ____ MANY ____ FEW)
____ D.S. PROGRESSIVE AND CUTOFFS
____ IRREGULAR LATERAL MOVEMENT
____ AVULSION
____ IRREGULAR WIDENING
____ GENERAL WIDENING

2. RATE: DESCRIBE RATE FOR MOVEMENT CHOSEN ABOVE

_______ FT/YR
_______ OTHER (SPECIFY____________)

E. VERTICAL MOVEMENT (INCLUDE SPECIFIC GUAGE RECORD IF AVAILABLE AND HOW MOVEMENT DETERMINED)

1. TYPE & EXTENT:

____ AGGRADATION (____ GENERAL ____ LOCAL)
____ DEGRADATION (____ GENERAL ____ LOCAL)

2. RATE AND LOCATION:

RATE:___________ UNITS:___________
LOCATION(S) IF LOCAL ____________
____
____

3. GRADE CONTROL: (SPECIFY NATURAL OR MAN MADE)

LOCATION	DESCRIPTION	DROP ACROSS CONTROL (FT)

F. BANKS

1. GENERAL:

_______ MEAN HEIGHT(FT) ____/____ MIN./ MAX. (DATUM:________)
_______ MEAN SLOPE ____/____ MIN./MAX.

2. COMMENT ON EXTENT OF INSTABILITY:

____ STABLE
____ OUTER BANK IN BENDWAYS
____ IRREGULAR LOCAL INSTABILITY
____ GENERAL INSTABILITY
____ PERIODIC WET SEASON INSTABILITY

3. PRIMARY CAUSES OF FAILURE (RANK AS 1,2,3,ETC. IN PRIORITY):

____ TOE SCOUR
____ DIRECT ATTACK
____ RILLING/GULLYING
____ SHEET EROSION
____ OTHER (SPECIFY______________)
____ RAPID DRAWDOWN,LOWERED BASE FLOW LEVEL
____ PORE WATER PRESSURE-SLUMPING
____ SEEPAGE/PIPING/LEACHING
____ FREEZE-THAW

4. VEGETATION (_____% VEGETATED):

____ GRASS
____ SHRUBS
____ OTHER (SPECIFY______________)
____ DECIDIOUS TREES
____ CONIFEROUS TREES

DENSITY OF GROWTH:____ LOW ____ MODERATE ____ DENSE

5. ARTIFICIAL BANK PROTECTION:

____ NONE
____ LOCAL
____ GENERAL

TYPE	LOCATION

G. SEDIMENT/SOILS

1. SIZES (% BY WEIGHT): (OR ATTACH GRADATION CURVE(S)

BANKS	BED	SIZE
		COBBLES TO BOULDERS (> 2.5")
		COARSE GRAVEL (0.6"-2.5")
		MEDIUM GRAVEL (0.3"-0.6")
		VERY FINE TO FINE GRAVEL (0.08"-0.3")
		COARSE TO VERY COARSE SAND (0.5-2.0 MM)
		MEDIUM SAND (0.25-0.5 MM)
		FINE TO VERY FINE SAND (0.062-0.25 MM)
		SILT (0.004-0.062 MM)
		CLAY (NON COHESIVE)
		CLAY (COHESIVE)

DESCRIBE HOW SAMPLED OR ESTIMATED:

2. SPECIFIC WEIGHT OF SEDIMENT________LB/CUFT
   WATER TEMPERATURE _____ DEG F/C ____ DATE
   _____ DEG F/C ____ DATE

3. DEPTH OF ALLUVIUM IN BED:

____ NONE ____ MODERATE
____ SHALLOW ____ DEEP

ESTIMATED DEPTH:__________(FT)

4. TRANSPORT: (INCLUDE SED. RATING CURVE IF AVAILABLE)

MAINLY:____ BEDLOAD ____ SUSPENDED LOAD ____ WASH LOAD
____ MIXED

ESTIMATED: _________ TONS/DAY AT ________CFS
_________ ________

(OR TONS/YEAR)

HOW ESTIMATED:________________________

5. BED REGIME AT __________ CFS (DOMINANT DISCHARGE)

____ PLANE BED, RIPPLES
____ DUNES
____ UPPER TRANSITION, PLANE BED
____ ANTIDUNES
____ CHUTES AND POOLS

6. GENERAL:

ARE BANKS STRATIFIED?
DO ERODIBLE LENSES OCCUR UNDER BED?
IS BED ARMORED?   IS THAT THE BED GRADATION GIVEN?
DO TRIBUTARIES CARRY HEAVY SEDIMENT LOADS?

V. STREAM MODIFICATIONS

A. ELEMENTS (RANK 1,2,3 ETC. IN ORDER OF IMPORTANCE):

____ SHORTENING-CUTOFFS
____ CLEARING & SNAGGING
____ DREDGING
____ GEN. ENLARGING
____ DEEPENING/WIDENING
____ ALIGNMENT CHANGE
____ FLOW CONTROL
____ LEVEES
____ GRADE CONTROL
____ BANK PROTECTION
____ HYDRAULIC STRUC (TYPE______)
____ SURFACING (IE. CONCRETE)
____ DIVERSION INTO CHANNEL
____ DIVERSION OUT OF CHANNEL
____ BASIN MODIFICATIONS
____ OTHER (SPECIFY________)

B. CRITERIA SOURCES:

DESIGN PERFORMED	CRITERIA SOURCE (IE. EM,ETL,ETC.)

C. EVALUATION OF WORK IN STREAM

1. RATING:

____ FULLY SUCCESSFUL
____ MODERATELY SUCCESSFUL
____ MODERATELY UNSUCCESSFULL
____ UNSUCCESSFUL

2. RATIONALE FOR "MOD. UNSUCCESSFUL" AND "UNSUCCESSFUL" RATINGS:

____ PROJECT EXCEEDED REASONABLE OR PREDICTED MAINTANENCE COSTS TO SUCH AN EXTENT AS TO CONSTITUTE A BURDEN.

____ THE DESIGN PURPOSE OF THE STRUCTURE OR MEASURE WAS NOT FULFILLED TO SUCH AN EXTENT AS TO CONSTITUTE "UNSUCCESSFUL" RATING.

____ THE STRUCTURAL INTEGRITY OR STABILITY OF THE HYDRAULIC STRUCTURE(S) OR REACH IS (ARE) IN JEOPARDY.

____ FLOWS EXCEEDING DESIGN FLOWS COULD CAUSE DAMAGE APPROACHING A CATASTROPHIC CONDITION.

____ FLOOD STAGES WERE INCREASED AS A RESULT OF THIS PROJECT TO SUCH AN EXTENT AS TO CONSTITUTE AN "UNSUCCESSFUL" RATING.

____ UNFORSEEN ADVERSE REACTIONS EITHER UPSTREAM OR DOWNSTREAM HAVE OCCURED AND ARE OF A MAGNITUDE TO CONSTITUTE AN "UNSUCCESSFUL" RATING.

____ OTHER (SPECIFY):

VI. ADDITIONAL DESIGN GUIDANCE WOULD HAVE GREATLY AIDED THE DESIGN OF THIS PROJECT IN THE FOLLOWING AREAS:

DESIGN	NEEDED CRITERIA/CMTS.

VII. ADD ADDITIONAL COMMENTS PERTINENT TO THE DESIGN REACH. INCLUDE COMMENTS ON RELIABILITY OF SPECIFIC DATA ENTRIES. INCLUDE A LIST OF ATTACHMENTS.

VIII. COMMENT ON YEARLY OPERATION AND MAINTANENCE COSTS. (INCLUDE PARTIES RESPONSIBLE FOR WORK AND PAYMENT AND BUDGETED OR FORECAST MAINTANENCE COSTS AND TYPE)

APPENDIX C: LOCAL FLOOD PROTECTION PROJECT INVENTORY MEETING AGENDA

LOCAL FLOOD PROTECTION PROJECT
INVENTORY MEETING AGENDA

PART I. GENERAL QUESTIONS

1. What types of flood-control problems are commonly faced within your District? What types of streams are common within your District? What types of projects are you presently working on?

2. What have been your preferred methods in dealing with these problems? Do design criteria or rules of thumb exist for these solutions?

3. What postconstruction channel responses have you commonly encountered in your flood protection projects (e.g. aggradation, degradation, meandering, bank failure, etc.)?

4. Describe typical design scenarios for your flood-control projects. What are normal time and money constraints in each section or branch? How are hydraulic and hydrologic analyses done for local protection projects?

5. Where do you feel design criteria are most needed? How can we best spend our research dollars in this area? Where do you see your District going in the future in this area? In which design areas do you feel your District has design expertise?

PART II: SPECIAL TOPICS

Riprap

6. What are the major causes of riprap failure in your District? Do you have any failures due to inadequate size? How do you presently design and size riprap? How can WES best support you in our riprap research?

Grade Control

7. What types do you have experience with? What design criteria do you use for drop heights, spacing, and basin design? Performance? How can WES best support you in this area?

Miscellaneous Bank Protection and Structures

8. What types do you have experience with? How can WES best support you here?

Environmental Concerns

9. How has concern for the environment impacted your flood control project designs? What environmental design features have you used? What agencies have you worked with? Working relationship?

O & M

10. How do you estimate O&M costs? What are your inspection procedures? Are estimates verified or do you have some good O&M data?

Project Review

11. What common types of review comments have you received from Division/OCE? What about the review process for this type of project gives you the most headaches?

PART III. SPECIFIC STREAMS

12. Why was the project built?

13. Stream description:
    - alluvial, type (refer to type list enclosed)
    - bed and bank material
    - stability considerations
    - effects of vegetation, flow control, other
    - basic data Q,W,D,V,d50,S

14. What was done?

15. Stream response?

16. Would this be a good project to study in detail?

17. Are there some other projects you would recommend for further study or that are not included on the inventory sheet?

APPENDIX D: DETAILED SURVEY RESULTS

This appendix contains a detailed listing of the responses to the agenda questions found in Appendix C. Table D1 gives all the responses to the questions by District. In Table D1, pages D3 through D13 cover responses from 14 Districts, pages D14 through D24 cover responses to the same questions from 13 other Districts, and pages D25 through D35 concludes responses to the questions from the last 10 Districts surveyed, including the New England Division. Table D2 gives the totals for all Dictricts. Tables D3 through D12 give a breakdown of modification type by stream type for each Division, and Table D13 gives the same breakdown for the totals for all Divisions. Table D14 gives the totals of all Divisions as percentages.

TABLE D1 Agenda Question Responses

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
QUESTION 1.														
TYPES OF FLOOD CONTROL PROBLEMS														
AGGRADATION/ SILTING			x	x			x	x	x	x	x	x		
BACKWATER FLOODING														
BANK ATTACK BY BRAIDED STREAM	x	x	x	x	x	x	x			x				
BANK ATTACK BY MEANDERING STREAM		x	x	x	x		x						x	x
BANK FAILURE, GENERAL		x												
BRIDGE OPENINGS INADEQUATE								x	x				x	
CLOGGING BY VEGETATION/ BAR STABILIZATION				x								x		
CLOGGING OF STREAM BY BARS	x									x				x
DEBRIS ATTACK & JAMS			x				x			x				
DEGRADATION/SCOUR/EROSION							x	x	x			x		
DRAINAGE INADEQUATE														
EROSION OF STRUCTURES/WEAR/REHABILITATION	x			x					x					
FAN, ALLUVIAL INSTABILITY				x	x	x	x			x				
FAULT LIFTING AND SHIFTING							x							
FLASH FLOODING							x	x		x				
FLOOD PLAIN ENCROACHMENT/ URBANIZATION	x						x		x	x	x	x	x	
GRAVEL MINING IN/NEAR THE STREAMS	x				x									
ICE JAMS				x										
INSTABILITY, GENERAL								x	x	x				
LAKE LEVELS RISING														
LANDSLIDES/ BANK SLUFFING					x									
OUTLET SIZES INADEQUATE FOR INTERIOR DRAINAGE														
RIGHTS-OF-WAY INSUFFICIENT								x	x					
SCOUR AROUND STRUCTURES														
SEDIMENT LOADS, HEAVY	x	x	x	x			x			x				
SEEPAGE THROUGH LEVEES						x								
SHORE PROTECTION														
TIDAL INFLUENCE DEPOSITION		x			x	x						x		
UPGRADE OF EXISTING STRUCTURES									x					
WAVE ATTACK		x				x								
MOST COMMON STREAM TYPES														
B1 (STRAIGHT BEDLOAD, MIGRATING SAND WAVES)														
B2 (BEDLOAD WITH ALTERNATE SIDE BARS)					x		x							x
B3 (LOW SINUOSITY BEDLOAD WITH SIDE BARS AND CHUTES)		x	x	x					x				x	x
B4 (MEANDERING/BRAIDED BEDLOAD WITH CHUTES AND BARS)	x			x			x		x	x				
B5 (BAR-BRAIDED VERY HIGH BEDLOAD)	x									x				
S1 (STRAIGHT, NARROW, DEEP, LOW SUSP. LOAD)		x												
S2 (NARROW, HIGHLY SINUOUS, NO BARS, LOW SUSP. LOAD)		x				x		x	x					
S3 (NARROW, HIGHLY SINUOUS, SMALL POINT BARS, SUSP. LOAD)	x		x					x	x					x
S4 (MANY CHANNELS WITH VEGE. BETWEEN, HIGH SUSP. LOAD)							x			x				

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
M1 (NARROW, DEEP, STRAIGHT, MIXED LOAD)														
M2 (FAIRLY STABLE ALTERNATE BARS, MIXED LOAD)					x	x		x	x		x	x		
M3 (TRUE MEANDERING CHANNEL, WIDE BARS, MIXED LOAD)	x	x	x		x	x	x	x	x		x	x	x	x
M4 (HIGER LOAD, SINUOUS-BRAIDED, MIXED LOAD)				x		x	x			x				
M5 (FAIRLY STABLE ISLAND BRAIDED CHANNEL, MIXED LOAD)			x				x							
ALLUVIAL FANS	x			x		x	x			x				
ARROYOS, EPHEMERAL							x			x				
COBBLE OR ROCK BED AND STEEP	x	x	x	x	x	x	x			x				
OTHER NON-ALLUVIAL														
TIDAL INFLUENCED/ SWAMPY		x				x								

PRESENT PROJECT CONCERN (1980 - PRESENT)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
BANK PROTECTION/REHABILITATION	x	x	x	x	x	x	x	x	x	x				
BYPASS CHANNELS					x					x				
CLEARING & SNAGGING											x			x
CONCRETE CHANNELS					x		x			x	x			
CONDUITS OR SIMILAR STRUCTURES										x				
CONTROL STRUCTURES														
DEBRIS/SEDIMENT BASINS			x				x			x				
DIKES, GROINS	x		x							x				
DIVERSIONS	x											x		
ENLARGEMENT/ IMPROVEMENT		x				x		x	x	x	x	x	x	x
FLOODPROOFING														
FLOOD INSURANCE STUDIES														
FLOW CONTROL DAMS AND RESERVOIRS/BASINS	x					x				x	x	x		
GRADE CONTROL									x		x	x	x	
KELLNER JACKS										x				
LEVEES & LEVEE REPAIR	x	x	x	x	x	x	x	x	x	x	x			
LOW FLOW CHANNELS														
PL 99 REPAIRS				x	x									
PUMPING STATIONS/ PONDING														
SCOUR/SEDIMENT TRANSPORT STUDIES							x			x				
SHORE RELATED PROJECTS, LAKE OR SEA														
SHORTENING/STRAIGHTENING						x	x	x				x		
SOIL CEMENT BANK PROTECTION							x			x				
SUPERCRITICAL CHANNELS							x			x				
URBAN DRAINAGE									x	x	x	x	x	

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
QUESTION 2.														
COMMON METHODS USED														
AL - ALIGNMENT CHANGE, RELOCATION				x	x	x	x	x	x	x				
BP - BANK PROTECTION (RIPRAP)	x	x	x	x	x	x	x	x	x	x	x	x		x
BP - BANK PROTECTION (GABIONS)				x			x			x				
BP - BANK PROTECTION (SOIL CEMENT)							x			x				
BP - BANK PROTECTION (GOBI MAT)										x				
BP - BANK PROTECTION (WILLOWS)														
BP - BANK PROTECTION (TIRE MATTRESSES)														
BP - BANK PROTECTION (WIRE ENCASED RIPRAP)										x				
BP - BANK PROTECTION (SHEET PILE)														
BP - BANK PROTECTION (CRIBS)														
BP - BANK PROTECTION (HYDROLINE MATTING)														
BP - BANK PROTECTION (FABRIFORM)														
BP - BANK PROTECTION (ROCK SAUSAGES)														
BP - BANK PROTECTION (DOUBLEWALL)														
BP - BANK PROTECTION (MIRAMAT/ ENKMAT)														
BP - BANK PROTECTION (PAVING BLOCK)														
BM - BASIN MODIFICATIONS/ MANAGEMENT														
CS - CLEARING AND SNAGGING				x		x	x	x			x	x		x
DB - DEBRIS BASINS, SEDIMENT TRAPS			x				x			x				
DI - DIVERSION INTO CHANNELS	x					x	x	x		x		x		
DO - DIVERSION OUT OF CHANNELS	x					x	x	x	x	x		x		x
DR - DREDGING														
DE - DEEPENING						x	x				x		x	x
EN - GENERAL ENLARGING, "IMPROVEMENT"				x	x	x	x	x	x	x	x	x	x	x
EV - ENVIRONMENTAL FEATURES			x		x		x			x	x			
EX - SELECTIVE EXCAVATION	x	x			x	x	x	x	x	x	x	x		x
FC - FLOW CONTROL, FLOOD CONTROL DAMS	x					x	x			x	x	x		
GC - GRADE CONTROL, DROPS, WEIRS, SILLS					x		x		x	x	x	x	x	
HI - HIGH FLOW CHANNEL, COMPLEX GEOMETRY					x		x	x			x			
LV - LEVEES, FLOODWALLS, DIKES		x	x	x	x	x	x	x	x	x	x	x		
PI - PILOT CHANNELS	x						x			x	x			
RE - RECREATIONAL FEATURES					x	x	x							
RT - TRANSITION STRUCTURES/FEATURES							x			x				
SH - SHORTENING, CUTOFFS, STRAIGHTENING				x		x	x	x	x		x	x	x	
SU - SURFACING, PAVING, CONCRETE CHANNEL					x		x	x	x	x				
TR - RIVER TRAINING STRUCTURES	x	x					x			x				
XC - AUXILLIARY CHANNEL/ NEW CHANNEL					x					x		x		
OO - OTHER (LANDSIDE FILL)					x									
OO - OTHER (DETENTION BASINS)									x			x		
OO - OTHER (CONDUITS, SIPHONS, ETC.)										x				
OO - OTHER (DAM REMOVAL)														
OO - OTHER (FLOODPROOFING)														

(Continued)

(Sheet 3 of 33)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
QUESTION 3. POST CONSTRUCTION PROBLEMS														
AGGRADATION/DEPOSITION/SEDIMENTATION, GENERAL			x		x	x	x	x	x	x	x			x
BANK FAILURE SLOUGHING, SLIDING, ETC.					x			x	x	x		x		x
DEBRIS ATTACK & JAMS			x											
DEGRADATION/SCOUR, GENERAL				x	x	x	x	x	x	x				
DEPOSITION, LOCAL (BARS, MOUTH, JUNCTION)										x				x
DIVERSION CHANNEL PROBLEMS														
ENVIRONMENTAL PROBLEMS														
EROSION OF CONCRETE	x													
FILTER FABRIC CLOGGING/ FAILURE														
FLANKING OF STRUCTURES					x					x				
FLOOD HEIGHT INCREASE UPSTREAM								x						
GABION FAILURE (WEAR, UNDERMINING, ETC.)				x										
HEADCUTTING				x							x			x
ICE ATTACK & JAMS	x													
INSTABILITY, GENERAL								x	x	x				
LEVEE OVERTOPPING, TIEBACK								x						
LEVEES FAIL, OLDER				x			x			x				
LOW FLOW CHANNEL MEANDERING OR SILTING							x			x				
MISOPERATION OF STRUCTURES														
REGIME ALTERATION						x	x			x				
RIPRAP FAILURE (FOR WHATEVER REASON - SEE BELOW)	x	x	x	x	x	x		x	x	x				x
SCOUR, LOCAL												x	x	
STRUCTURAL FAILURE														
TIDAL ACTION		x										x		
TOE ATTACK, SCOUR FROM BRAIDED STREAMS	x	x	x	x	x		x			x				
TOE ATTACK, SCOUR FROM MEANDERING STREAMS	x	x	x	x		x	x		x	x		x		x
TRANSITION DESIGN INADEQUATE										x				x
VEGETATIVE CLOGGING/CHOKING														
WAVE ATTACK		x				x								
WIDENING														
QUESTION 5. CRITERIA NEEDS (SEE SPECIAL TOPICS ALSO)														
AERIAL PHOTO INTERPRETATION														
BACKFILL REQUIREMENTS FOR PL 99					x									
BANK PROTECTION METHODS, VARIETY					x		x	x	x	x	x			
BRIDGE OPENING CRITERIA								x	x				x	
CHANNEL DESIGN, GRASS LINED							x							
CHANNELIZATION EFFECTS ON FISH						x								
CHANNELIZATION GUIDANCE, PRACTICAL, CHECKLIST													x	
COHESIVE SOIL STABILITY								x	x					
CRIB WALL DESIGN														

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
DATA BASE ON DIFFERENT DESIGNS/ INTER-COMMUNICATION														
DEBRIS/DETENTION BASIN/TRAP DESIGN			x			x				x				
DEWATERING A BASIN														
DOWNSTREAM EFFECTS OF FLOW CONTROL						x	x							
EAST COAST SHORE PROTECTION MANUAL (LOW ENERGY ENVRO)														
ENVIRONMENTAL FEATURE EFFECTS ON HYDRAULICS														
EXTREME EVENT FLOW LINE EXTRAPOLATION											x			
FILTER FABRIC USE					x									
FILTER MATERIAL/BEDDING														x
FLOATING MATS														
FLOODPROOFING														
GABION USE AND LIMITATIONS				x				x	x		x			
GATE OPERATION, ONE GATE														
GATES, FLAP HEAD LOSS														
GRADATIONS FOR DIKES AND GROINS							x							
GRADE DETERMINATION, STABLE								x	x				x	
GRAVEL BED STREAMS						x								
GRAVEL YIELDS, SAFE	x													
GROINS AND BANK PROTECTION		x	x											
GROUTED RIPRAP DESIGN GUIDANCE						x					x			
HARDPOINT DESIGN		x												
HEC-6 SIMPLIFIED/ SIMPLE TRANSPORT MODELS	x				x									
HYDROLOGY/HYDRAULICS ESTIMATE WITH LIMITED DATA														
ICE/DEBRIS HYDRAULIC ANALYSIS	x													
INEXPENSIVE SOLUTIONS TO COMMON PROBLEMS														
INTERIOR DRAINAGE REQUIREMENTS OFTEN TOO CUMBERSOME						x	x							
LEVEE FAILURE, OLDER LEVEES, REHABILITATION										x				
LEVEE FREEBOARD GUIDANCE						x				x				
LOW FLOW/ ENVIRONMENTAL/ PILOT CHANNELS														
LOW HEAD STRUCTURE ENERGY DISSIPATERS														
LOW WATER CROSSINGS														
MANUAL PRECEDENCE AND APPLICABILITY		x												
MEANDER LOOPS OPEN FOR LOW FLOW											x			
PUMP ROUTING PROGRAM														
RECONNAISSANCE, ONE DAY, GUIDANCE														
REVETMENT, NON-CONTINUOUS EFFECTS						x								
RIPRAP SIZING FOR FLOW DOWN FACE/OVERTOPPING						x								
ROUGHNESS IN ALLUVIAL CHANNELS											x			
ROUGHNESS OF CONCRETE, SURFACE, BENDS, INLETS											x	x		
SAMPLING SEDIMENT, LOAD ESTIMATION	x													
SCOUR, LOCAL PREDICTION				x			x							
SCOUR, LOW VELOCITY														
SEC. 32 RE-EVALUATION/ OTHER DEMO PROJECTS			x		x	x				x				
SEDIMENT MANUAL, EXPEDITE/ SEDIMENT STUDIES														
SEDIMENT TRANSPORT ANALYSIS, HEAVY LOAD STREAMS	x													
SEDIMENT YIELD & ANALYSIS, EPHEMERAL/URBAN STREAMS					x					x				
SENSITIVITY ANALYSIS														

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
SIDE DRAINAGE ENERGY DISSIPATORS/ INLET DESIGN												x		
SIDE SLOPE STABILITY ANALYSIS/ BANK FAILURE MECHANISMS								x						
SIPHON DESIGN											x			
SOIL CEMENT AND RCC						x	x							
STABILITY ANALYSIS, GENERAL / REGIME ANALYSIS										x				x
STILLING BASINS, TRAPEZOIDAL											x			
SUMP DESIGN, PUMPING STATION														
SUPERCRITICAL CHANNELS WITH OVERBANK SUBCRITICAL											x			
TIDAL EFFECTS IN CHANNEL DESIGN						x								
TRAINING METHODS/MEANDERS, RIVER		x												
TRANSITION DESIGN/ TIE IN OF REVETMENT											x		x	x
VEGETATIVE COVER INFORMATION														
VERIFY MODEL STUDY RESULTS														
WAVE RUN UP														
WES MODELLING COSTS AND TIME/ RESULTS NOT DEVELOPED								x	x					

--S P E C I A L T O P I C S------

R I P R A P

FAILURE CAUSES

	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
BANK SLOUGHING/ FOUNDATIONAL FAILURE/ UPLIFT														
BEDDING POOR				x		x								
CHANNEL CLOGGING SPEEDS OR ANGLES FLOW														
DEBRIS ATTACK			x											
DREDGING NEAR TOE														
FABRIC SLIDING, CLOGGING, OR FAILURE						x			x					
FLANKING		x				x				x				
FLOW DOWN THE STONE FACE/BEHIND OR ABOVE STONE TOP						x				x				
GATE OR OTHER STRUCTURE OPERATION FAULTY	x													
ICE ATTACK OR PLUCKING	x			x										
MAINTENANCE LACK														
PLACEMENT/QUALITY CONTROL POOR				x										x
SCOUR AROUND/BELOW STRUCTURES													x	
SCOUR FROM ANGLED FLOW INTO BANK (MEANDERS, BRAIDS, ETC.)	x	x	x	x	x	x	x		x	x				
SCOUR, GENERAL ALONG TOE		x	x	x	x	x		x	x	x				x
SEEPAGE EXIT														
SIZE INADEQUATE									x					
SIZE INADEQUATE, OLDER SITE			x		x									

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
SIZES/GRADADATIONS NOT AVAILABLE OR NOT USED	x			x	x									
TRANSITION DESIGN							x				x	x		
VANDALISM														
WAVE ATTACK, WIND, NAVIGATION, PROP WASH						x			x					x
WEATHERING, POOR STONE QUALITY	x								x	x	x			
OTHER METHODS USED														
BUREAU OF PUBLIC ROADS METHOD														
OUR OWN SIZING METHOD			x							x				
OUR OWN SPECIFIED GRADATIONS	x	x	x		x		x			x				
OUR OWN VELOCITY DETERMINATION METHOD														
OUR OWN THICKNESS SPECIFICATION IN BASINS											x			
SHORE PROTECTION MANUAL		x					x							
SORENSON PAPER		x												
CORPS PROGRAM H7011														
RIPRAP RELATED RESEARCH/GUIDANCE NEEDED														
ANGLED FLOW METHODS/ BETTER BEND ADJUSTMENT	x	x		x	x		x							
CONCRETE BLOCK MATS								x						
CONSTRUCTION TECHNIQUES IMPROVED														
D50 MIN OR MAX WHEN TO USE/ SAFETY FACTORS TO USE							x							
EM METHOD NOT ALWAYS APPROPRIATE, OVERDESIGN (?)			x	x		x	x			x			x	
END PROTECTION AND DESIGN						x								
EXTENT UP AND DOWNSTREAM			x			x					x			
FILTER CLOTH/FABRIC USE							x							
FILTER/FOUNDATIONAL DESIGN														
GRADATIONS, STANDARD, EASE THE CRITERIA	x			x	x		x							
GRAVEL AND SMALL SIZE USE				x										
GROINS, EFFECT ON SIZING BETWEEN							x							
GUIDE SPECIFICATION ON STONE TO USE														
HDC METHOD INFLEXIBLE														
ICE ATTACK DESIGN				x										
LAUNCHED RIPRAP/RIPRAP TOE, WINDROW REVETMENT					x				x					
MANUAL, ONE COMPREHENSIVE, COVERS ALL CASES		x												
METHOD PREFERENCES							x							
MODEL, WHEN NEEDED/ BETTER REPORTING														
MODELLING AT FULL SCALE								x						
PROP AND BARGE WASH SIZING														
QUALITY CONTROL														
RISK BASED DESIGN														

(Continued) (Sheet 7 of 33)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
ROUGHNESS TO USE FOR SIZING														
SHAPE EFFECTS (COBBLES)							x							
SHORE PROTECTION Kd FACTORS														
SIZING DURING LEVEE DESIGN														
SIZING NEAR STRUCTURES/PIERS													x	
STEEP STREAM AND/OR SMALL DITCH PROTECTION														
STILLING BASIN SIZING														
THICKNESS EFFECTS AND ADJUSTMENTS											x			
TOE DEPTH AND DESIGN CRITERIA, ALL CASES	x			x	x		x							x
TOPSOIL AND SEEDING ON RIPRAP			x				x							
TRAINING COURSE FOR INSPECTORS														
UNDERWATER/TURBULENT EMPLACEMENT					x									
UP SLOPE DISTANCE CRITERIA						x	x							
VEGETATION EFFECTS ON RIPRAP			x			x	x							
VELOCITY, WHICH VELOCITY TO USE	x		x				x							

G R A D E C O N T R O L

GRADE CONTROL RESEARCH/GUIDANCE NEEDED

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
COMPHEHENSIVE CRITERIA NEEDED										x	x			
COMPLEX CREST SECTION														
DASHED LINE EXTENSION ON CIT TYPE STRUCTURES IN HDC														
DOWNSTREAM SCOUR									x					
HEADCUTTING									x					
HEIGHT LIMITATIONS				x										
INEXPENSIVE DROP STRUCTURES NEEDED											x	x		
ROCK DROP STRUCTURES									x					
ROCK OR OTHER BASIN DESIGN								x	x		x			
SAFETY FEATURES												x		
SEDIMENTATION PROBLEMS							x							
SHEET PILE DESIGN AND ENERGY DROP OVER IT								x	x					
SLOPE STABILITY BETWEEN STRUCTURES/BEST SLOPE								x	x					
SPACING				x										
STRUCTURE, DIFFERENT TYPES														
SUBMERGENCE CURVE FOR STRAIGHT DROP STRUCTURE														

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
MISCELLANEOUS EXPERTISE OR KNOWLEDGE														
BANK FAILURE MECHANISMS														
BRIDGE PLUGGING DESIGN CRITERIA														
CHANNEL DESIGN, SMALL														
CHECKLIST FOR ENVIRONMENTAL CONCERNS														
CHECKLISTS FOR DESIGN AND REPORTING					x									
CLEARING & SNAGGING														
CRIBS														
DAMS & OUTLET WORKS									x					
DEBRIS JAMS														
DEBRIS/RETENTION BASINS			x				x							
DISCHARGE, DESIGN DETERMINATION														
DOUBLEWALL, CONCRETE BLOCKS														
DRIFT EMBANKMENT		x												
DUMPING OF STONE IN HIGH WATER (PL99)				x										
ENERGY DISSIPATION DEVICES									x					
EROSION CONTROL								x						
FABRIFORM														
FILTER FABRIC										x				
GABIONS				x			x			x				
GOBI MAT										x				
GRADE CONTROL							x	x	x					
GROINS & DIKES	x		x				x							
GROUTED STONE RIPRAP							x			x				
H PILES					x			x						
HYDROLINE MATTING														
INTERIOR DRAINAGE														
KELLNER JACKS										x				
LEASED PUMP FOR FLOODING														
LEVEE HEIGHT DETERMINATION														
LOW FLOW CHANNELS														
MEANDER MODELLING														
MIRAMAT/ ENKMAT														
MODELLING UNSTEADY FLOW						x								
OTHER BANK PROTECTION METHODS										x				
PUMPS, SUBMERSIBLE														
REGIME ANALYSIS														
RIPRAP			x					x	x	x				
RIPRAP REHABILITATION								x	x					
ROCK HARDPOINTS					x									
ROCK SAUSAGES														
ROCK SPECIFICATION														
ROUGHNESS COEFFICIENTS														
SCOUR PREDICTION	x													
SEDIMENTATION STUDIES														

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
SEEDING MIXTURE														
SEEDING MIXTURE														
SOIL CEMENT						x	x		x	x				
STABLE CHANNEL DESIGN					x			x						
SUPERCRITICAL CHANNELS							x							
TIDAL EFFECTS														
TRANSITION DESIGN							x							
TRENCH/WINDROW REVETMENT					x				x					
VELOCITY CRITERIA FOR CHANNEL DESIGN												x		
VELOCITY DETERMINATION FOR RIPRAP DESIGN														
WIRE ENCASED RIPRAP										x				
E N V I R O N M E N T A L C O N C E R N S														
DESIGN FEATURES														
ARCHEOLOGICAL INVESTIGATIONS										x				
BERM WIDTH/ BERMS		x						x						
BOULDERS									x					
CONSTRUCTION TIMING/ CONSTRUCTION LIMITATIONS		x			x									
CRIBS														
DEFLECTOR VANES														
DETENTION STORAGE														
DREDGED MATERIAL PLACEMENT RESTRICTIONS														
EXCAVATE ONE SIDE ONLY														
FISH PASSAGE SILLS, LADDERS, ETC.									x					
FLOW MAINTENANCE														
GRAVEL MINING, USEFULL, HAULTED														
SOIL/GRAVEL/COBBLE SURFACING OF RIPRAP								x	x					
GROINS & DIKES		x	x											
LANDSCAPING							x							
LOW FLOW/PILOT/ENVIRONMENTAL CHANNELS							x	x						
MAINTAIN MEANDER LOOPS								x			x			
MATERIAL USE LIMITATIONS														
MITIGATION AREA/ WILDLIFE HABITAT AREA							x			x				
MULTI-LEVEL INTAKES									x					
NOTCHED DROP STRUCTURES								x	x					
NOTCHED JETTY														
POOL AND RIFFLE														x
REVEGETATION		x					x			x				
REVETMENT LIMITATION		x												
SHELVES		x												
SILT FENCES														

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NPA	NPP	NPS	NPW	SPN	SPK	SPL	MRK	MRO	SWA	SWF	SWG	SWL	SWT
V SHAPED CHANNEL														
VEGETATION SAVING		x	x					x	x	x				
WIERS														
P R O J E C T R E V I E W														
COMMON REVIEWER COMMENTS														
ECONOMIC ANALYSIS CHANGES		x												
EFFECT OF FLOWS LARGER THAN DESIGN											x			
FEATURE OMITTED OR UNDER DESIGNED			x						x					
LACK OF DETAILED INFORMATION FOR INDEPENDENT ASSESSMENT		x							x				x	
OUTDATED OR INCORRECT MANUALS OR GUIDANCE USED		x	x						x					
REAL ESTATE DOCUMENTATION LACK		x												
REDUCE HIGH COSTS OF RIPRAP AND BRIDGE MOD.								x						
REQUIRE MORE OR DIFFERENT ALTERNATIVES					x									
SEDIMENT ANALYSIS/ CHANNEL STABILITY INADEQUATE											x			x
SENSITIVITY ANALYSIS REQUIRED														
WHY CHANGE DESIGN DURING PHASES										x				

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
QUESTION 1.													
TYPES OF FLOOD CONTROL PROBLEMS													
AGGRADATION/ SILTING		x			x	x		x				x	
BACKWATER FLOODING											x	x	x
BANK ATTACK BY BRAIDED STREAM													
BANK ATTACK BY MEANDERING STREAM		x		x	x	x		x	x			x	
BANK FAILURE, GENERAL			x		x		x	x	x			x	
BRIDGE OPENINGS INADEQUATE													
CLOGGING BY VEGETATION/ BAR STABILIZATION			x	x								x	x
CLOGGING OF STREAM BY BARS													
DEBRIS ATTACK & JAMS					x			x					
DEGRADATION/SCOUR/EROSION		x			x	x			x			x	
DRAINAGE INADEQUATE													
EROSION OF STRUCTURES/WEAR/REHABILITATION								x					
FAN, ALLUVIAL INSTABILITY		x											
FAULT LIFTING AND SHIFTING													
FLASH FLOODING													
FLOOD PLAIN ENCROACHMENT/ URBANIZATION			x	x			x					x	
GRAVEL MINING IN/NEAR THE STREAMS							x						
ICE JAMS	x				x								
INSTABILITY, GENERAL	x					x		x				x	
LAKE LEVELS RISING	x				x								
LANDSLIDES/ BANK SLUFFING							x	x					
OUTLET SIZES INADEQUATE FOR INTERIOR DRAINAGE											x		
RIGHTS-OF-WAY INSUFFICIENT													
SCOUR AROUND STRUCTURES													
SEDIMENT LOADS, HEAVY	x			x								x	
SEEPAGE THROUGH LEVEES							x						
SHORE PROTECTION			x										
TIDAL INFLUENCE DEPOSITION													
UPGRADE OF EXISTING STRUCTURES													
WAVE ATTACK							x						
MOST COMMON STREAM TYPES													
B1 (STRAIGHT BEDLOAD, MIGRATING SAND WAVES)													
B2 (BEDLOAD WITH ALTERNATE SIDE BARS)						x	x					x	
B3 (LOW SINUOSITY BEDLOAD WITH SIDE BARS AND CHUTES)							x					x	
B4 (MEANDERING/BRAIDED BEDLOAD WITH CHUTES AND BARS)													
B5 (LONG BRAIDED VERY HIGH BEDLOAD)													
S1 (STRAIGHT, NARROW, DEEP, LOW SUSP. LOAD)								x					
S2 (NARROW, HIGHLY SINUOUS, NO BARS, LOW SUSP. LOAD)	x		x	x	x	x		x	x			x	
S3 (NARROW, HIGHLY SINUOUS, SMALL POINT BARS, SUSP. LOAD)	x		x	x		x	x	x	x	x		x	
S4 (MANY CHANNELS WITH VEGE. BETWEEN, HIGH SUSP. LOAD)													
M1 (NARROW, DEEP, STRAIGHT, MIXED LOAD)											x		

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
M2 (FAIRLY STABLE ALTERNATE BARS, MIXED LOAD)		x	x	x	x	x	x	x	x		x	x	x
M3 (TRUE MEANDERING CHANNEL, WIDE BARS, MIXED LOAD)		x		x	x	x	x	x	x			x	x
M4 (HIGER LOAD, SINUOUS-BRAIDED, MIXED LOAD)					x					x		x	
M5 (FAIRLY STABLE ISLAND BRAIDED CHANNEL, MIXED LOAD)	x		x										
ALLUVIAL FANS													
ARROYOS, EPHEMERAL													
COBBLE OR ROCK BED AND STEEP	x				x	x	x			x			
OTHER NON-ALLUVIAL						x		x		x			
TIDAL INFLUENCED/ SWAMPY													x
PRESENT PROJECT CONCERN (1980 - PRESENT)													
BANK PROTECTION/REHABILITATION	x	x	x	x	x	x	x	x	x			x	x
BYPASS CHANNELS													
CLEARING & SNAGGING	x		x	x			x		x		x		x
CONCRETE CHANNELS													
CONDUITS OR SIMILAR STRUCTURES			x										
CONTROL STRUCTURES													
DEBRIS/SEDIMENT BASINS				x		x							
DIKES, GROINS						x							
DIVERSIONS				x									x
ENLARGEMENT/ IMPROVEMENT	x	x		x	x	x	x	x	x		x	x	x
FLOODPROOFING							x						
FLOOD INSURANCE STUDIES	x												
FLOW CONTROL DAMS AND RESERVOIRS/BASINS			x					x					
GRADE CONTROL	x			x		x			x			x	
KELLNER JACKS													
LEVEES & LEVEE REPAIR	x	x	x	x	x		x	x		x		x	x
LOW FLOW CHANNELS							x	x					
PL 99 REPAIRS													
PUMPING STATIONS/ PONDING	x							x			x	x	
SCOUR/SEDIMENT TRANSPORT STUDIES		x			x						x		
SHORE RELATED PROJECTS, LAKE OR SEA					x								
SHORTENING/STRAIGHTENING	x	x											
SOIL CEMENT BANK PROTECTION													
SUPERCRITICAL CHANNELS													
URBAN DRAINAGE			x	x	x								

QUESTION 2.

COMMON METHODS USED

	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
AL - ALIGNMENT CHANGE, RELOCATION	x			x	x	x	x					x	x
BP - BANK PROTECTION (RIPRAP)	x	x	x	x	x	x	x	x	x	x	x	x	x
BP - BANK PROTECTION (GABIONS)				x	x	x	x		x			x	

(Continued) (Sheet 13 of 33)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
BP - BANK PROTECTION (SOIL CEMENT)													
BP - BANK PROTECTION (GOBI MAT)													
BP - BANK PROTECTION (WILLOWS)													
BP - BANK PROTECTION (TIRE MATTRESSES)													
BP - BANK PROTECTION (WIRE ENCASED RIPRAP)													
BP - BANK PROTECTION (SHEET PILE)				x									
BP - BANK PROTECTION (CRIBS)					x	x							
BP - BANK PROTECTION (HYDROLINE MATTING)					x								
BP - BANK PROTECTION (FABRIFORM)						x							
BP - BANK PROTECTION (ROCK SAUSAGES)						x							
BP - BANK PROTECTION (DOUBLEWALL)													
BP - BANK PROTECTION (MIRAMAT/ ENKMAT)													
BP - BANK PROTECTION (PAVING BLOCK)								x					
BM - BASIN MODIFICATIONS/ MANAGEMENT	x						x						
CS - CLEARING AND SNAGGING	x		x	x	x		x	x	x		x	x	x
DB - DEBRIS BASINS, SEDIMENT TRAPS		x		x		x	x						
DI - DIVERSION INTO CHANNELS	x			x	x								x
DO - DIVERSION OUT OF CHANNELS	x			x	x								x
DR - DREDGING	x			x			x					x	x
DE - DEEPENING	x	x	x		x		x					x	x
EN - GENERAL ENLARGING, "IMPROVEMENT"	x	x	x	x	x	x	x	x	x	x	x	x	x
EV - ENVIRONMENTAL FEATURES	x						x	x				x	
EX - SELECTIVE EXCAVATION	x	x		x	x	x	x		x			x	x
FC - FLOW CONTROL, FLOOD CONTROL DAMS		x	x				x						
GC - GRADE CONTROL, DROPS, WEIRS, SILLS	x		x	x	x	x	x		x			x	
HI - HIGH FLOW CHANNEL, COMPLEX GEOMETRY	x				x	x	x	x	x			x	
LV - LEVEES, FLOODWALLS, DIKES	x	x	x	x	x	x	x	x	x	x	x	x	x
PI - PILOT CHANNELS	x	x				x	x	x					
RE - RECREATIONAL FEATURES	x												
RT - TRANSITION STRUCTURES/FEATURES	x								x			x	
SH - SHORTENING, CUTOFFS, STRAIGHTENING	x			x	x	x	x	x	x	x	x	x	x
SU - SURFACING, PAVING, CONCRETE CHANNEL			x	x	x								
TR - RIVER TRAINING STRUCTURES						x						x	
XC - AUXILLIARY CHANNEL/ NEW CHANNEL							x						
OO - OTHER (LANDSIDE FILL)													
OO - OTHER (DETENTION BASINS)			x					x					
OO - OTHER (CONDUITS, SIPHONS, ETC.)			x										
OO - OTHER (DAM REMOVAL)													
OO - OTHER (FLOODPROOFING)													

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
QUESTION 3. POST CONSTRUCTION PROBLEMS													
AGGRADATION/DEPOSITION/SEDIMENTATION, GENERAL	x	x	x		x	x	x		x		x	x	
BANK FAILURE SLOUGHING, SLIDING, ETC.	x	x	x	x	x	x	x	x	x		x	x	
DEBRIS ATTACK & JAMS								x					
DEGRADATION/SCOUR, GENERAL	x	x			x	x	x		x		x	x	
DEPOSITION, LOCAL (BARS, MOUTH, JUNCTION)						x	x					x	
DIVERSION CHANNEL PROBLEMS	x												
ENVIRONMENTAL PROBLEMS	x					x	x						
EROSION OF CONCRETE													
FILTER FABRIC CLOGGING/ FAILURE								x					
FLANKING OF STRUCTURES	x				x		x						
FLOOD HEIGHT INCREASE UPSTREAM													
GABION FAILURE (WEAR, UNDERMINING, ETC.)	x				x	x	x					x	
HEADCUTTING					x				x			x	
ICE ATTACK & JAMS			x										
INSTABILITY, GENERAL	x			x	x			x				x	
LEVEE OVERTOPPING, TIEBACK													
LEVEES FAIL, OLDER	x	x	x				x	x					
LOW FLOW CHANNEL MEANDERING OR SILTING	x	x				x	x	x					
MISOPERATION OF STRUCTURES													
REGIME ALTERATION	x				x		x						
RIPRAP FAILURE (FOR WHATEVER REASON - SEE BELOW)	x					x	x	x				x	
SCOUR, LOCAL	x					x							
STRUCTURAL FAILURE								x					
TIDAL ACTION													
TOE ATTACK, SCOUR FROM BRAIDED STREAMS													
TOE ATTACK, SCOUR FROM MEANDERING STREAMS	x	x	x		x	x		x				x	
TRANSITION DESIGN INADEQUATE						x			x				
VEGETATIVE CLOGGING/CHOKING				x									x
WAVE ATTACK		x											
WIDENING	x				x							x	
QUESTION 5. CRITERIA NEEDS (SEE SPECIAL TOPICS ALSO)													
AERIAL PHOTO INTERPRETATION					x								
BACKFILL REQUIREMENTS FOR PL 99													
BANK PROTECTION METHODS, VARIETY					x	x	x	x	x				
BRIDGE OPENING CRITERIA				x									
CHANNEL DESIGN, GRASS LINED					x								
CHANNELIZATION EFFECTS ON FISH													
CHANNELIZATION GUIDANCE, PRACTICAL, CHECKLIST							x		x				
COHESIVE SOIL STABILITY													
CRIB WALL DESIGN								x					
DATA BASE ON DIFFERENT DESIGNS/ INTER-COMMUNICATION					x				x				
DEBRIS/DETENTION BASIN/TRAP DESIGN					x								

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
DEWATERING A BASIN	x												
DOWNSTREAM EFFECTS OF FLOW CONTROL		x					x						
EAST COAST SHORE PROTECTION MANUAL (LOW ENERGY ENVRO)													
ENVIRONMENTAL FEATURE EFFECTS ON HYDRAULICS							x						
EXTREME EVENT FLOW LINE EXTRAPOLATION							x						
FILTER FABRIC USE									x				
FILTER MATERIAL/BEDDING					x								
FLOATING MATS													
FLOODPROOFING													
GABION USE AND LIMITATIONS							x	x					
GATE OPERATION, ONE GATE		x											
GATES, FLAP HEAD LOSS				x									
GRADATIONS FOR DIKES AND GROINS													
GRADE DETERMINATION, STABLE													
GRAVEL BED STREAMS													
GRAVEL YIELDS, SAFE													
GROINS AND BANK PROTECTION													
GROUTED RIPRAP DESIGN GUIDANCE				x		x							
HARDPOINT DESIGN													
HEC-6 SIMPLIFIED/ SIMPLE TRANSPORT MODELS	x				x		x						
HYDROLOGY/HYDRAULICS ESTIMATE WITH LIMITED DATA									x				
ICE/DEBRIS HYDRAULIC ANALYSIS								x					
INEXPENSIVE SOLUTIONS TO COMMON PROBLEMS													
INTERIOR DRAINAGE REQUIREMENTS OFTEN TOO CUMBERSOME	x			x									
LEVEE FAILURE, OLDER LEVEES, REHABILITATION	x	x											
LEVEE FREEBOARD GUIDANCE	x	x	x	x									
LOW FLOW/ ENVIRONMENTAL/ PILOT CHANNELS	x					x	x	x					
LOW HEAD STRUCTURE ENERGY DISSIPATERS												x	
LOW WATER CROSSINGS								x					
MANUAL PRECEDENCE AND APPLICABILITY						x							
MEANDER LOOPS OPEN FOR LOW FLOW													
PUMP ROUTING PROGRAM											x		
RECONNAISSANCE, ONE DAY, GUIDANCE							x	x	x				
REVETMENT, NON-CONTINUOUS EFFECTS													
RIPRAP SIZING FOR FLOW DOWN FACE/OVERTOPPING													
ROUGHNESS IN ALLUVIAL CHANNELS				x		x	x						
ROUGHNESS OF CONCRETE, SURFACE, BENDS, INLETS													
SAMPLING SEDIMENT, LOAD ESTIMATION													
SCOUR, LOCAL PREDICTION					x			x					
SCOUR, LOW VELOCITY			x										
SEC. 32 RE-EVALUATION/ OTHER DEMO PROJECTS									x				
SEDIMENT MANUAL, EXPEDITE/ SEDIMENT STUDIES					x								
SEDIMENT TRANSPORT ANALYSIS, HEAVY LOAD STREAMS													
SEDIMENT YIELD & ANALYSIS, EPHEMERAL/URBAN STREAMS													
SENSITIVITY ANALYSIS													
SIDE DRAINAGE ENERGY DISSIPATORS/ INLET DESIGN								x					
SIDE SLOPE STABILITY ANALYSIS/ BANK FAILURE MECHANISMS								x					

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
SIPHON DESIGN													
SOIL CEMENT AND RCC													
STABILITY ANALYSIS, GENERAL / REGIME ANALYSIS													
STILLING BASINS, TRAPEZOIDAL													
SUMP DESIGN, PUMPING STATION	x												
SUPERCRITICAL CHANNELS WITH OVERBANK SUBCRITICAL													
TIDAL EFFECTS IN CHANNEL DESIGN													
TRAINING METHODS/MEANDERS, RIVER					x			x					
TRANSITION DESIGN/ TIE IN OF REVETMENT				x	x		x	x	x				
VEGETATIVE COVER INFORMATION					x								
VERIFY MODEL STUDY RESULTS									x				
WAVE RUN UP							x	x					
WES MODELLING COSTS AND TIME/ RESULTS NOT DEVELOPED	x												

------SPECIAL TOPICS------

RIPRAP

FAILURE CAUSES

FAILURE CAUSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
BANK SLOUGHING/ FOUNDATIONAL FAILURE/ UPLIFT	x				x		x	x		x		x	x
BEDDING POOR													
CHANNEL CLOGGING SPEEDS OR ANGLES FLOW													
DEBRIS ATTACK													
DREDGING NEAR TOE													
FABRIC SLIDING, CLOGGING, OR FAILURE	x					x		x	x		x		x
FLANKING	x				x		x						
FLOW DOWN THE STONE FACE/BEHIND OR ABOVE STONE TOP	x				x								
GATE OR OTHER STRUCTURE OPERATION FAULTY												x	x
ICE ATTACK OR PLUCKING	x				x								
MAINTENANCE LACK													
PLACEMENT/QUALITY CONTROL POOR					x		x						x
SCOUR AROUND/BELOW STRUCTURES						x		x	x			x	
SCOUR FROM ANGLED FLOW INTO BANK (MEANDERS, BRAIDS, ETC.)	x	x			x	x		x		x			
SCOUR, GENERAL ALONG TOE	x	x			x					x			
SEEPAGE EXIT							x	x					
SIZE INADEQUATE					x			x					
SIZE INADEQUATE, OLDER SITE								x					
SIZES/GRADADATIONS NOT AVAILABLE OR NOT USED					x	x	x		x			x	x
TRANSITION DESIGN						x	x				x		
VANDALISM				x	x	x	x						
WAVE ATTACK, WIND, NAVIGATION, PROP WASH		x			x		x						
WEATHERING, POOR STONE QUALITY					x								

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
OTHER METHODS USED													
BUREAU OF PUBLIC ROADS METHOD													
OUR OWN SIZING METHOD													
OUR OWN SPECIFIED GRADATIONS		x										x	
OUR OWN VELOCITY DETERMINATION METHOD						x							
OUR OWN THICKNESS SPECIFICATION IN BASINS													
SHORE PROTECTION MANUAL													
SORENSON PAPER													
CORPS PROGRAM H7011													
RIPRAP RELATED RESEARCH/GUIDANCE NEEDED													
ANGLED FLOW METHODS/ BETTER BEND ADJUSTMENT								x					
CONCRETE BLOCK MATS								x					
CONSTRUCTION TECHNIQUES IMPROVED													x
D50 MIN OR MAX WHEN TO USE/ SAFETY FACTORS TO USE													
EM METHOD NOT ALWAYS APPROPRIATE, OVERDESIGN (?)	x			x	x	x	x		x				x
END PROTECTION AND DESIGN													
EXTENT UP AND DOWNSTREAM		x											
FILTER CLOTH/FABRIC USE							x					x	
FILTER/FOUNDATIONAL DESIGN					x		x	x					
GRADATIONS, STANDARD, EASE THE CRITERIA							x						x
GRAVEL AND SMALL SIZE USE													
GROINS, EFFECT ON SIZING BETWEEN													
GUIDE SPECIFICATION ON STONE TO USE					x								x
HDC METHOD INFLEXIBLE	x												
ICE ATTACK DESIGN	x												
LAUNCHED RIPRAP/RIPRAP TOE, WINDROW REVETMENT													
MANUAL, ONE COMPREHENSIVE, COVERS ALL CASES					x	x		x					x
METHOD PREFERENCES						x		x	x				
MODEL, WHEN NEEDED/ BETTER REPORTING													
MODELLING AT FULL SCALE													
PROP AND BARGE WASH SIZING	x	x					x						
QUALITY CONTROL					x								
RISK BASED DESIGN													
ROUGHNESS TO USE FOR SIZING													
SHAPE EFFECTS (COBBLES)													
SHORE PROTECTION Kd FACTORS													
SIZING DURING LEVEE DESIGN	x		x										
SIZING NEAR STRUCTURES/PIERS													
STEEP STREAM AND/OR SMALL DITCH PROTECTION								x			x		
STILLING BASIN SIZING		x						x					

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
THICKNESS EFFECTS AND ADJUSTMENTS	x						x						x
TOE DEPTH AND DESIGN CRITERIA, ALL CASES	x							x					
TOPSOIL AND SEEDING ON RIPRAP													
TRAINING COURSE FOR INSPECTORS													x
UNDERWATER/TURBULENT EMPLACEMENT	x										x		
UP SLOPE DISTANCE CRITERIA													
VEGETATION EFFECTS ON RIPRAP													
VELOCITY, WHICH VELOCITY TO USE	x				x								

G R A D E   C O N T R O L

GRADE CONTROL RESEARCH/GUIDANCE NEEDED

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
COMPHEHENSIVE CRITERIA NEEDED							x		x			x	
COMPLEX CREST SECTION	x												
DASHED LINE EXTENSION ON CIT TYPE STRUCTURES IN HDC													
DOWNSTREAM SCOUR					x								
HEADCUTTING					x								
HEIGHT LIMITATIONS													
INEXPENSIVE DROP STRUCTURES NEEDED											x		
ROCK DROP STRUCTURES													
ROCK OR OTHER BASIN DESIGN					x								
SAFETY FEATURES	x		x		x								
SEDIMENTATION PROBLEMS			x		x								
SHEET PILE DESIGN AND ENERGY DROP OVER IT													
SLOPE STABILITY BETWEEN STRUCTURES/BEST SLOPE					x		x						
SPACING							x						
STRUCTURE, DIFFERENT TYPES							x		x				
SUBMERGENCE CURVE FOR STRAIGHT DROP STRUCTURE	x												

M I S C E L L A N E O U S   E X P E R T I S E   O R   K N O W L E D G E

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
BANK FAILURE MECHANISMS							x						
BRIDGE PLUGGING DESIGN CRITERIA	x												
CHANNEL DESIGN, SMALL													
CHECKLIST FOR ENVIRONMENTAL CONCERNS					x								

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
CHECKLISTS FOR DESIGN AND REPORTING													
CLEARING & SNAGGING	::										x		
CRIBS					x	x							
DAMS & OUTLET WORKS													
DEBRIS JAMS								x					
DEBRIS/RETENTION BASINS		x											
DISCHARGE, DESIGN DETERMINATION												x	
DOUBLEWALL, CONCRETE BLOCKS													
DRIFT EMBANKMENT													
DUMPING OF STONE IN HIGH WATER (PL99)													
ENERGY DISSIPATION DEVICES													
EROSION CONTROL													
FABRIFORM						x							
FILTER FABRIC	x			x									
GABIONS	x				x								
GOBI MAT													
GRADE CONTROL						x						x	
GROINS & DIKES													
GROUTED STONE RIPRAP						x							
H PILES								x					
HYDROLINE MATTING					x								
INTERIOR DRAINAGE	x												
KELLNER JACKS													
LEASED PUMP FOR FLOODING				x									
LEVEE HEIGHT DETERMINATION							x						
LOW FLOW CHANNELS								x					
MEANDER MODELLING					x								
MIRAMAT/ ENKMAT													
MODELLING UNSTEADY FLOW													
OTHER BANK PROTECTION METHODS					x								
PUMPS, SUBMERSIBLE	x												
REGIME ANALYSIS											x		
RIPRAP					x								
RIPRAP REHABILITATION													
ROCK HARDPOINTS													
ROCK SAUSAGES						x							
ROCK SPECIFICATION					x								
ROUGHNESS COEFFICIENTS						x	x						
SCOUR PREDICTION													
SEDIMENTATION STUDIES					x						x		
SEEDING MIXTURE				x									
SEEDING MIXTURE				x									
SOIL CEMENT													
STABLE CHANNEL DESIGN		x			x						x	x	
SUPERCRITICAL CHANNELS						x							
TIDAL EFFECTS													
TRANSITION DESIGN													

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
TRENCH/WINDROW REVETMENT													
VELOCITY CRITERIA FOR CHANNEL DESIGN													
VELOCITY DETERMINATION FOR RIPRAP DESIGN						x							
WIRE ENCASED RIPRAP													
E N V I R O N M E N T A L C O N C E R N S													
DESIGN FEATURES													
ARCHEOLOGICAL INVESTIGATIONS													
BERM WIDTH/ BERMS													
BOULDERS					x								
CONSTRUCTION TIMING/ CONSTRUCTION LIMITATIONS							x				x		x
CRIBS													
DEFLECTOR VANES						x							
DETENTION STORAGE													
DREDGED MATERIAL PLACEMENT RESTRICTIONS												x	
EXCAVATE ONE SIDE ONLY													x
FISH PASSAGE SILLS, LADDERS, ETC.													
FLOW MAINTENANCE						x							
GRAVEL MINING, USEFULL, HAULTED													
SOIL/GRAVEL/COBBLE SURFACING OF RIPRAP													
GROINS & DIKES		x											
LANDSCAPING													
LOW FLOW/PILOT/ENVIRONMENTAL CHANNELS						x	x						
MAINTAIN MEANDER LOOPS													
MATERIAL USE LIMITATIONS						x							
MITIGATION AREA/ WILDLIFE HABITAT AREA							x					x	x
MULTI-LEVEL INTAKES													
NOTCHED DROP STRUCTURES													
NOTCHED JETTY		x											
POOL AND RIFFLE		x											
REVEGETATION													
REVETMENT LIMITATION												x	
SHELVES													
SILT FENCES													
V SHAPED CHANNEL													
VEGETATION SAVING						x					x	x	x
WIERS													x

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NCS	NCR	NCC	NCE	NCB	ORP	ORH	ORL	ORN	LMS	LMM	LMK	LMN
P R O J E C T R E V I E W													
COMMON REVIEWER COMMENTS													
ECONOMIC ANALYSIS CHANGES													
EFFECT OF FLOWS LARGER THAN DESIGN													
FEATURE OMITTED OR UNDER DESIGNED													
LACK OF DETAILED INFORMATION FOR INDEPENDENT ASSESSMENT	x			x	x	x							
OUTDATED OR INCORRECT MANUALS OR GUIDANCE USED						x							
REAL ESTATE DOCUMENTATION LACK													
REDUCE HIGH COSTS OF RIPRAP AND BRIDGE MOD.													
REQUIRE MORE OR DIFFERENT ALTERNATIVES													
SEDIMENT ANALYSIS/ CHANNEL STABILITY INADEQUATE					x		x						
SENSITIVITY ANALYSIS REQUIRED													
WHY CHANGE DESIGN DURING PHASES													

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
QUESTION 1.										
TYPES OF FLOOD CONTROL PROBLEMS										
AGGRADATION/ SILTING	x								x	
BACKWATER FLOODING										
BANK ATTACK BY BRAIDED STREAM										
BANK ATTACK BY MEANDERING STREAM	x		x	x		x				
BANK FAILURE, GENERAL		x	x			x				
BRIDGE OPENINGS INADEQUATE										
CLOGGING BY VEGETATION/ BAR STABILIZATION					x	x	x		x	x
CLOGGING OF STREAM BY BARS	x									
DEBRIS ATTACK & JAMS										
DEGRADATION/SCOUR/EROSION	x									
DRAINAGE INADEQUATE								x		x
EROSION OF STRUCTURES/WEAR/REHABILITATION									x	
FAN, ALLUVIAL INSTABILITY										
FAULT LIFTING AND SHIFTING										
FLASH FLOODING										
FLOOD PLAIN ENCROACHMENT/ URBANIZATION								x	x	x
GRAVEL MINING IN/NEAR THE STREAMS										
ICE JAMS	x									
INSTABILITY, GENERAL										
LAKE LEVELS RISING										
LANDSLIDES/ BANK SLUFFING										
OUTLET SIZES INADEQUATE FOR INTERIOR DRAINAGE										x
RIGHTS-OF-WAY INSUFFICIENT										
SCOUR AROUND STRUCTURES			x							
SEDIMENT LOADS, HEAVY		x		x						
SEEPAGE THROUGH LEVEES										
SHORE PROTECTION					x	x				
TIDAL INFLUENCE DEPOSITION					x		x		x	
UPGRADE OF EXISTING STRUCTURES		x								
WAVE ATTACK						x				
MOST COMMON STREAM TYPES										
B1 (STRAIGHT BEDLOAD, MIGRATING SAND WAVES)		x								
B2 (BEDLOAD WITH ALTERNATE SIDE BARS)	x	x	x	x						
B3 (LOW SINUOSITY BEDLOAD WITH SIDE BARS AND CHUTES)		x	x	x						x
B4 (MEANDERING/BRAIDED BEDLOAD WITH CHUTES AND BARS)	x									
B5 (BAR-BRAIDED VERY HIGH BEDLOAD)										
S1 (STRAIGHT, NARROW, DEEP, LOW SUSP. LOAD)					x					
S2 (NARROW, HIGHLY SINUOUS, NO BARS, LOW SUSP. LOAD)	x		x		x	x	x	x		x
S3 (NARROW, HIGHLY SINUOUS, SMALL POINT BARS, SUSP. LOAD)			x		x	x				x

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
S4 (MANY CHANNELS WITH VEGE. BETWEEN, HIGH SUSP. LOAD)					x	x				x
M1 (NARROW, DEEP, STRAIGHT, MIXED LOAD)										
M2 (FAIRLY STABLE ALTERNATE BARS, MIXED LOAD)	x		x	x			x			x
M3 (TRUE MEANDERING CHANNEL, WIDE BARS, MIXED LOAD)	x			x		x		x	x	
M4 (HIGER LOAD, SINUOUS-BRAIDED, MIXED LOAD)				x					x	
M5 (FAIRLY STABLE ISLAND BRAIDED CHANNEL, MIXED LOAD)		x		x						
ALLUVIAL FANS										
ARROYOS, EPHEMERAL										
COBBLE OR ROCK BED AND STEEP	x					x				
OTHER NON-ALLUVIAL	x	x	x	x		x				
TIDAL INFLUENCED/ SWAMPY				x	x	x	x		x	x
PRESENT PROJECT CONCERN (1980 - PRESENT)										
BANK PROTECTION/REHABILITATION	x	x	x	x	x	x		x		
BYPASS CHANNELS					x					x
CLEARING & SNAGGING	x				x	x	x	x		
CONCRETE CHANNELS										
CONDUITS OR SIMILAR STRUCTURES		x	x							
CONTROL STRUCTURES										x
DEBRIS/SEDIMENT BASINS	x									
DIKES, GROINS										
DIVERSIONS										
ENLARGEMENT/ IMPROVEMENT					x	x	x	x		x
FLOODPROOFING								x		
FLOOD INSURANCE STUDIES										
FLOW CONTROL DAMS AND RESERVOIRS/BASINS	x									x
GRADE CONTROL										
KELLNER JACKS										
LEVEES & LEVEE REPAIR	x	x		x	x					
LOW FLOW CHANNELS										
PL 99 REPAIRS										
PUMPING STATIONS/ PONDING										
SCOUR/SEDIMENT TRANSPORT STUDIES		x		x						
SHORE RELATED PROJECTS, LAKE OR SEA						x				
SHORTENING/STRAIGHTENING										
SOIL CEMENT BANK PROTECTION										
SUPERCRITICAL CHANNELS										
URBAN DRAINAGE										

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
QUESTION 2.										
COMMON METHODS USED										
AL - ALIGNMENT CHANGE, RELOCATION	x	x		x		x				
BP - BANK PROTECTION (RIPRAP)	x	x	x	x	x	x	x	x	x	
BP - BANK PROTECTION (GABIONS)			x	x						
BP - BANK PROTECTION (SOIL CEMENT)										
BP - BANK PROTECTION (GOBI MAT)										
BP - BANK PROTECTION (WILLOWS)						x				
BP - BANK PROTECTION (TIRE MATTRESSES)						x				
BP - BANK PROTECTION (WIRE ENCASED RIPRAP)										
BP - BANK PROTECTION (SHEET PILE)										
BP - BANK PROTECTION (CRIBS)			x							
BP - BANK PROTECTION (HYDROLINE MATTING)										
BP - BANK PROTECTION (FABRIFORM)										
BP - BANK PROTECTION (ROCK SAUSAGES)										
BP - BANK PROTECTION (DOUBLEWALL)	x									
BP - BANK PROTECTION (MIRAMAT/ ENKMAT)			x							
BP - BANK PROTECTION (PAVING BLOCK)										
CS - CLEARING AND SNAGGING		x		x	x	x	x	x	x	
DB - DEBRIS BASINS, SEDIMENT TRAPS	x									
DI - DIVERSION INTO CHANNELS										x
DO - DIVERSION OUT OF CHANNELS										x
DR - DREDGING	x			x	x			x		
DE - DEEPENING					x	x				
EN - GENERAL ENLARGING, "IMPROVEMENT"	x	x	x	x	x	x	x	x		x
EV - ENVIRONMENTAL FEATURES			x			x				
EX - SELECTIVE EXCAVATION	x	x			x	x	x	x	x	
FC - FLOW CONTROL, FLOOD CONTROL DAMS	x								x	x
GC - GRADE CONTROL, DROPS, WEIRS, SILLS	x			x						
HI - HIGH FLOW CHANNEL, COMPLEX GEOMETRY						x				
LV - LEVEES, FLOODWALLS, DIKES	x	x	x	x	x	x			x	x
PI - PILOT CHANNELS	x		x		x					
RE - RECREATIONAL FEATURES										
RT - TRANSITION STRUCTURES/FEATURES										
SH - SHORTENING, CUTOFFS, STRAIGHTENING		x			x	x				x
SU - SURFACING, PAVING, CONCRETE CHANNEL	x	x								
TR - RIVER TRAINING STRUCTURES			x		x					
XC - AUXILLIARY CHANNEL/ NEW CHANNEL					x					
OO - OTHER (LANDSIDE FILL)										
OO - OTHER (DETENTION BASINS)										x
OO - OTHER (CONDUITS, SIPHONS, ETC.)			x							
OO - OTHER (DAM REMOVAL)	x									
OO - OTHER (FLOODPROOFING)			x						x	

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
QUESTION 3. POST CONSTRUCTION PROBLEMS										
AGGRADATION/DEPOSITION/SEDIMENTATION, GENERAL	x			x	x	x		x	x	
BANK FAILURE SLOUGHING, SLIDING, ETC.	x		x			x	x	x		x
DEBRIS ATTACK & JAMS					x			x		
DEGRADATION/SCOUR, GENERAL	x	x						x		
DEPOSITION, LOCAL (BARS, MOUTH, JUNCTION)	x				x	x				
DIVERSION CHANNEL PROBLEMS										
ENVIRONMENTAL PROBLEMS										
EROSION OF CONCRETE										
FILTER FABRIC CLOGGING/ FAILURE										
FLANKING OF STRUCTURES										
FLOOD HEIGHT INCREASE UPSTREAM										
GABION FAILURE (WEAR, UNDERMINING, ETC.)	x		x							
HEADCUTTING										
ICE ATTACK & JAMS	x									
INSTABILITY, GENERAL								x		
LEVEE OVERTOPPING, TIEBACK										
LEVEES FAIL, OLDER										
LOW FLOW CHANNEL MEANDERING OR SILTING	x					x				
MISOPERATION OF STRUCTURES										x
REGIME ALTERATION	x									
RIPRAP FAILURE (FOR WHATEVER REASON - SEE BELOW)		x	x	x						
SCOUR, LOCAL			x							x
STRUCTURAL FAILURE										
TIDAL ACTION									x	
TOE ATTACK, SCOUR FROM BRAIDED STREAMS	x									
TOE ATTACK, SCOUR FROM MEANDERING STREAMS	x	x	x					x		
TRANSITION DESIGN INADEQUATE										
VEGETATIVE CLOGGING/CHOKING					x	x	x	x	x	
WAVE ATTACK			x							
WIDENING										x
QUESTION 5. CRITERIA NEEDS (SEE SPECIAL TOPICS ALSO)										
AERIAL PHOTO INTERPRETATION										
BACKFILL REQUIREMENTS FOR PL 99										
BANK PROTECTION METHODS, VARIETY	x		x							
BRIDGE OPENING CRITERIA										
CHANNEL DESIGN, GRASS LINED										
CHANNELIZATION EFFECTS ON FISH										
CHANNELIZATION GUIDANCE, PRACTICAL, CHECKLIST						x	x			
COHESIVE SOIL STABILITY										
CRIB WALL DESIGN										
DATA BASE ON DIFFERENT DESIGNS/ INTER-COMMUNICATION					x		x			
DEBRIS/DETENTION BASIN/TRAP DESIGN										

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
DEWATERING A BASIN										
DOWNSTREAM EFFECTS OF FLOW CONTROL										
EAST COAST SHORE PROTECTION MANUAL (LOW ENERGY ENVRO)					x					
ENVIRONMENTAL FEATURE EFFECTS ON HYDRAULICS										
EXTREME EVENT FLOW LINE EXTRAPOLATION										
FILTER FABRIC USE				x						
FILTER MATERIAL/BEDDING										
FLOATING MATS					x					
FLOODPROOFING			x							
GABION USE AND LIMITATIONS			x							
GATE OPERATION, ONE GATE										
GATES, FLAP HEAD LOSS										
GRADATIONS FOR DIKES AND GROINS										
GRADE DETERMINATION, STABLE										
GRAVEL BED STREAMS										
GRAVEL YIELDS, SAFE										
GROINS AND BANK PROTECTION				x						
GROUTED RIPRAP DESIGN GUIDANCE								x		
HARDPOINT DESIGN										
HEC-6 SIMPLIFIED/ SIMPLE TRANSPORT MODELS		x		x					x	
HYDROLOGY/HYDRAULICS ESTIMATE WITH LIMITED DATA										
ICE/DEBRIS HYDRAULIC ANALYSIS										
INEXPENSIVE SOLUTIONS TO COMMON PROBLEMS			x						x	
INTERIOR DRAINAGE REQUIREMENTS OFTEN TOO CUMBERSOME										
LEVEE FAILURE, OLDER LEVEES, REHABILITATION										
LEVEE FREEBOARD GUIDANCE										
LOW FLOW/ ENVIRONMENTAL/ PILOT CHANNELS	x									
LOW HEAD STRUCTURE ENERGY DISSIPATERS										
LOW WATER CROSSINGS										
MANUAL PRECEDENCE AND APPLICABILITY		x								
MEANDER LOOPS OPEN FOR LOW FLOW										
PUMP ROUTING PROGRAM										
RECONNAISSANCE, ONE DAY, GUIDANCE		x								
REVETMENT, NON-CONTINUOUS EFFECTS										
RIPRAP SIZING FOR FLOW DOWN FACE/OVERTOPPING										
ROUGHNESS IN ALLUVIAL CHANNELS										
ROUGHNESS OF CONCRETE, SURFACE, BENDS, INLETS										
SAMPLING SEDIMENT, LOAD ESTIMATION										
SCOUR, LOCAL PREDICTION	x									
SCOUR, LOW VELOCITY										
SEC. 32 RE-EVALUATION/ OTHER DEMO PROJECTS	x									
SEDIMENT MANUAL, EXPEDITE/ SEDIMENT STUDIES									x	
SEDIMENT TRANSPORT ANALYSIS, HEAVY LOAD STREAMS										
SEDIMENT YIELD & ANALYSIS, EPHEMERAL/URBAN STREAMS				x						
SENSITIVITY ANALYSIS		x								
SIDE DRAINAGE ENERGY DISSIPATORS/ INLET DESIGN	x									

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
SIDE SLOPE STABILITY ANALYSIS/ BANK FAILURE MECHANISMS							x			
SIPHON DESIGN										
SOIL CEMENT AND RCC										
STABILITY ANALYSIS, GENERAL / REGIME ANALYSIS	x	x		x		x	x			
STILLING BASINS, TRAPEZOIDAL										
SUMP DESIGN, PUMPING STATION										
SUPERCRITICAL CHANNELS WITH OVERBANK SUBCRITICAL										
TIDAL EFFECTS IN CHANNEL DESIGN										
TRAINING METHODS/MEANDERS, RIVER										
TRANSITION DESIGN/ TIE IN OF REVETMENT	x									
VEGETATIVE COVER INFORMATION										
VERIFY MODEL STUDY RESULTS										
WAVE RUN UP										
WES MODELLING COSTS AND TIME/ RESULTS NOT DEVELOPED			x				x			

------S P E C I A L   T O P I C S------

R I P R A P

FAILURE CAUSES

	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
BANK SLOUGHING/ FOUNDATIONAL FAILURE/ UPLIFT	x			x			x			
BEDDING POOR										
CHANNEL CLOGGING SPEEDS OR ANGLES FLOW				x				x		
DEBRIS ATTACK										
DREDGING NEAR TOE	x									
FABRIC SLIDING, CLOGGING, OR FAILURE	x									
FLANKING	x								x	
FLOW DOWN THE STONE FACE/BEHIND OR ABOVE STONE TOP								x	x	
GATE OR OTHER STRUCTURE OPERATION FAULTY										x
ICE ATTACK OR PLUCKING	x	x								
MAINTENANCE LACK		x								
PLACEMENT/QUALITY CONTROL POOR										
SCOUR AROUND/BELOW STRUCTURES			x			x				
SCOUR FROM ANGLED FLOW INTO BANK (MEANDERS, BRAIDS, ETC.)		x	x	x				x	x	
SCOUR, GENERAL ALONG TOE	x	x							x	
SEEPAGE EXIT										
SIZE INADEQUATE	x									x
SIZE INADEQUATE, OLDER SITE		x		x						
SIZES/GRADADATIONS NOT AVAILABLE OR NOT USED									x	x
TRANSITION DESIGN	x									

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
VANDALISM	x									
WAVE ATTACK, WIND, NAVIGATION, PROP WASH						x			x	
WEATHERING, POOR STONE QUALITY										
OTHER METHODS USED										
BUREAU OF PUBLIC ROADS METHOD		x								
OUR OWN SIZING METHOD	x	x								
OUR OWN SPECIFIED GRADATIONS	x									
OUR OWN VELOCITY DETERMINATION METHOD										
OUR OWN THICKNESS SPECIFICATION IN BASINS										
SHORE PROTECTION MANUAL					x					
SORENSON PAPER										
CORPS PROGRAM H7011			x							
RIPRAP RELATED RESEARCH/GUIDANCE NEEDED										
ANGLED FLOW METHODS/ BETTER BEND ADJUSTMENT					x					
CONCRETE BLOCK MATS										
CONSTRUCTION TECHNIQUES INPROVED										
D50 MIN OR MAX WHEN TO USE/ SAFETY FACTORS TO USE			x		x					
EM METHOD NOT ALWAYS APPROPRIATE, OVERDESIGN (?)	x	x	x	x	x	x		x		
END PROTECTION AND DESIGN										
EXTENT UP AND DOWNSTREAM										
FILTER CLOTH/FABRIC USE										x
FILTER/FOUNDATIONAL DESIGN										
GRADATIONS, STANDARD, EASE THE CRITERIA			x	x		x	x	x	x	x
GRAVEL AND SMALL SIZE USE		x								
GROINS, EFFECT ON SIZING BETWEEN										
GUIDE SPECIFICATION ON STONE TO USE								x	x	
HDC METHOD INFLEXIBLE										
ICE ATTACK DESIGN										
LAUNCHED RIPRAP/RIPRAP TOE, WINDROW REVETMENT										
MANUAL, ONE COMPREHENSIVE, COVERS ALL CASES			x			x		x		x
METHOD PREFERENCES								x		x
MODEL, WHEN NEEDED/ BETTER REPORTING									x	x
MODELLING AT FULL SCALE										
PROP AND BARGE WASH SIZING										
QUALITY CONTROL										
RISK BASED DESIGN						x				

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
ROUGHNESS TO USE FOR SIZING			x							
SHAPE EFFECTS (COBBLES)										
SHORE PROTECTION Kd FACTORS					x					
SIZING DURING LEVEE DESIGN										
SIZING NEAR STRUCTURES/PIERS	x									
STEEP STREAM AND/OR SMALL DITCH PROTECTION	x			x	x					
STILLING BASIN SIZING										
THICKNESS EFFECTS AND ADJUSTMENTS										
TOE DEPTH AND DESIGN CRITERIA, ALL CASES										x
TOPSOIL AND SEEDING ON RIPRAP										
TRAINING COURSE FOR INSPECTORS										
UNDERWATER/TURBULENT EMPLACEMENT										
UP SLOPE DISTANCE CRITERIA										
VEGETATION EFFECTS ON RIPRAP				x						
VELOCITY, WHICH VELOCITY TO USE	x				x	x		x		
G R A D E C O N T R O L										
GRADE CONTROL RESEARCH/GUIDANCE NEEDED										
COMPHEHENSIVE CRITERIA NEEDED								x		
COMPLEX CREST SECTION										
DASHED LINE EXTENSION ON CIT TYPE STRUCTURES IN HDC										x
DOWNSTREAM SCOUR										
HEADCUTTING										
HEIGHT LIMITATIONS										
INEXPENSIVE DROP STRUCTURES NEEDED								x		
ROCK DROP STRUCTURES										
ROCK OR OTHER BASIN DESIGN										
SAFETY FEATURES										
SEDIMENTATION PROBLEMS				x						
SHEET PILE DESIGN AND ENERGY DROP OVER IT										
SLOPE STABILITY BETWEEN STRUCTURES/BEST SLOPE								x		
SPACING								x		
STRUCTURE, DIFFERENT TYPES										

(Continued)

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TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
MISCELLANEOUS EXPERTISE OR KNOWLEDGE										
BANK FAILURE MECHANISMS										
BRIDGE PLUGGING DESIGN CRITERIA										
CHANNEL DESIGN, SMALL							x			
CHECKLIST FOR ENVIRONMENTAL CONCERNS										
CHECKLISTS FOR DESIGN AND REPORTING										
CLEARING & SNAGGING					x					
CRIBS										
DAMS & OUTLET WORKS										
DEBRIS JAMS										
DEBRIS/RETENTION BASINS										
DISCHARGE, DESIGN DETERMINATION										
DOUBLEWALL, CONCRETE BLOCKS	x									
DRIFT EMBANKMENT										
DUMPING OF STONE IN HIGH WATER (PL99)										
ENERGY DISSIPATION DEVICES										
EROSION CONTROL										
FABRIFORM										
FILTER FABRIC			x							
GABIONS	x		x	x						
GOBI MAT										
GRADE CONTROL										
GROINS & DIKES										
GROUTED STONE RIPRAP										
H PILES										
HYDROLINE MATTING										
INTERIOR DRAINAGE										
KELLNER JACKS										
LEASED PUMP FOR FLOODING										
LEVEE HEIGHT DETERMINATION										
LOW FLOW CHANNELS										
MEANDER MODELLING										
MIRAMAT/ ENKMAT			x							
MODELLING UNSTEADY FLOW										
OTHER BANK PROTECTION METHODS										
PUMPS, SUBMERSIBLE										
REGIME ANALYSIS										
RIPRAP										
RIPRAP REHABILITATION										
ROCK HARDPOINTS										
ROCK SAUSAGES										
ROCK SPECIFICATION										

(Continued)

TABLE D1 (Continued)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
ROUGHNESS COEFFICIENTS										
SCOUR PREDICTION										
SEDIMENTATION STUDIES										
SEEDING MIXTURE										
SEEDING MIXTURE										
SOIL CEMENT										
STABLE CHANNEL DESIGN										
SUPERCRITICAL CHANNELS										
TIDAL EFFECTS									x	
TRANSITION DESIGN										
TRENCH/WINDROW REVETMENT										
VELOCITY CRITERIA FOR CHANNEL DESIGN									x	x
VELOCITY DETERMINATION FOR RIPRAP DESIGN										
WIRE ENCASED RIPRAP										

E N V I R O N M E N T A L   C O N C E R N S

DESIGN FEATURES

DESIGN FEATURES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
ARCHEOLOGICAL INVESTIGATIONS										
BERM WIDTH/ BERMS										x
BOULDERS		x	x							
CONSTRUCTION TIMING/ CONSTRUCTION LIMITATIONS	x			x	x	x	x		x	
CRIBS			x							
DEFLECTOR VANES										
DETENTION STORAGE										x
DREDGED MATERIAL PLACEMENT RESTRICTIONS						x				
EXCAVATE ONE SIDE ONLY				x		x	x			
FISH PASSAGE SILLS, LADDERS, ETC.					x					
FLOW MAINTENANCE										x
GRAVEL MINING, USEFULL, HAULTED	x									
SOIL/GRAVEL/COBBLE SURFACING OF RIPRAP				x						
GROINS & DIKES										
LANDSCAPING										
LOW FLOW/PILOT/ENVIRONMENTAL CHANNELS	x									
MAINTAIN MEANDER LOOPS										
MATERIAL USE LIMITATIONS										
MITIGATION AREA/ WILDLIFE HABITAT AREA			x			x	x			
MULTI-LEVEL INTAKES										

(Continued)

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Table D1 (Concluded)

AGENDA QUESTION RESPONSES	NED	NAN	NAP	NAB	NAO	SAW	SAC	SAM	SAS	SAJ
NOTCHED DROP STRUCTURES										
NOTCHED JETTY										
POOL AND RIFFLE										
REVEGETATION				x			x			
REVETMENT LIMITATION										
SHELVES										
SILT FENCES	x									
V SHAPED CHANNEL		x								
VEGETATION SAVING	x		x		x		x			
WIERS		x				x				
P R O J E C T R E V I E W										
COMMON REVIEWER COMMENTS										
ECONOMIC ANALYSIS CHANGES										
EFFECT OF FLOWS LARGER THAN DESIGN						x				
FEATURE OMITTED OR UNDER DESIGNED						x	x		x	
LACK OF DETAILED INFORMATION FOR INDEPENDENT ASSESSMENT	x						x			
OUTDATED OR INCORRECT MANUALS OR GUIDANCE USED		x		x	x		x			x
REAL ESTATE DOCUMENTATION LACK										
REDUCE HIGH COSTS OF RIPRAP AND BRIDGE MOD.										
REQUIRE MORE OR DIFFERENT ALTERNATIVES	x								x	
SEDIMENT ANALYSIS/ CHANNEL STABILITY INADEQUATE				x		x			x	
SENSITIVITY ANALYSIS REQUIRED		x								
WHY CHANGE DESIGN DURING PHASES										

(concluded)

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Table D2

Agenda Question Response Totals

AGENDA QUESTION RESPONSES

QUESTION 1.	
TYPES OF FLOOD CONTROL PROBLEMS	
AGGRADATION/ SILTING	15
BACKWATER FLOODING	3
BANK ATTACK BY BRAIDED STREAM	8
BANK ATTACK BY MEANDERING STREAM	18
BANK FAILURE, GENERAL	10
BRIDGE OPENINGS INADEQUATE	3
CLOGGING BY VEGETATION/ BAR STABILIZATION	11
CLOGGING OF STREAM BY BARS	4
DEBRIS ATTACK & JAMS	5
DEGRADATION/SCOUR/EROSION	10
DRAINAGE INADEQUATE	2
EROSION OF STRUCTURES/WEAR/REHABILITATION	5
FAN, ALLUVIAL INSTABILITY	6
FAULT LIFTING AND SHIFTING	1
FLASH FLOODING	3
FLOOD PLAIN ENCROACHMENT/ URBANIZATION	14
GRAVEL MINING IN/NEAR THE STREAMS	3
ICE JAMS	4
INSTABILITY, GENERAL	7
LAKE LEVELS RISING	2
LANDSLIDES/ BANK SLUFFING	3
OUTLET SIZES INADEQUATE FOR INTERIOR DRAINAGE	2
RIGHTS-OF-WAY INSUFFICIENT	2
SCOUR AROUND STRUCTURES	1
SEDIMENT LOADS, HEAVY	12
SEEPAGE THROUGH LEVEES	2
SHORE PROTECTION	3
TIDAL INFLUENCE DEPOSITION	7
UPGRADE OF EXISTING STRUCTURES	2
WAVE ATTACK	4
MOST COMMON STREAM TYPES	
B1 (STRAIGHT BEDLOAD, MIGRATING SAND WAVES)	1
B2 (BEDLOAD WITH ALTERNATE SIDE BARS)	10
B3 (LOW SINUOSITY BEDLOAD WITH SIDE BARS AND CHUTES)	12
B4 (MEANDERING/BRAIDED BEDLOAD WITH CHUTES AND BARS)	6
B5 (BAR-BRAIDED VERY HIGH BEDLOAD)	2
S1 (STRAIGHT,NARROW,DEEP,LOW SUSP. LOAD)	3
S2 (NARROW,HIGHLY SINUOUS,NO BARS,LOW SUSP. LOAD)	19
S3 (NARROW,HIGHLY SINUOUS,SMALL POINT BARS,SUSP. LOAD)	18

(Continued)

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Table D2 (Continued)

S4 (MANY CHANNELS WITH VEGE. BETWEEN, HIGH SUSP. LOAD)	5
M1 (NARROW,DEEP,STRAIGHT,MIXED LOAD)	1
M2 (FAIRLY STABLE ALTERNATE BARS,MIXED LOAD)	22
M3 (TRUE MEANDERING CHANNEL,WIDE BARS,MIXED LOAD)	26
M4 (HIGER LOAD,SINUOUS-BRAIDED,MIXED LOAD)	9
M5 (FAIRLY STABLE ISLAND BRAIDED CHANNEL,MIXED LOAD)	6
ALLUVIAL FANS	5
ARROYOS, EPHEMERAL	2
COBBLE OR ROCK BED AND STEEP	15
OTHER NON-ALLUVIAL	8
TIDAL INFLUENCED/ SWAMPY	9
PRESENT PROJECT CONCERN (1980 - PRESENT)	
BANK PROTECTION/REHABILITATION	28
BYPASS CHANNELS	4
CLEARING & SNAGGING	14
CONCRETE CHANNELS	4
CONDUITS OR SIMILAR STRUCTURES	4
CONTROL STRUCTURES	1
DEBRIS/SEDIMENT BASINS	6
DIKES,GROINS	4
DIVERSIONS	4
ENLARGEMENT/ IMPROVEMENT	25
FLOODPROOFING	2
FLOOD INSURANCE STUDIES	1
FLOW CONTROL DAMS AND RESERVOIRS/BASINS	9
GRADE CONTROL	9
KELLNER JACKS	1
LEVEES & LEVEE REPAIR	25
LOW FLOW CHANNELS	2
PL 99 REPAIRS	2
PUMPING STATIONS/ PONDING	4
SCOUR/SEDIMENT TRANSPORT STUDIES	7
SHORE RELATED PROJECTS, LAKE OR SEA	2
SHORTENING/STRAIGHTENING	6
SOIL CEMENT BANK PROTECTION	2
SUPERCRITICAL CHANNELS	2
URBAN DRAINAGE	8
QUESTION 2.	
COMMON METHODS USED	
AL - ALIGNMENT CHANGE, RELOCATION	18
BP - BANK PROTECTION (RIPRAP)	35
BP - BANK PROTECTION (GABIONS)	11

(Continued)

(Sheet 2 of 10)

Table D2 (Continued)

BP - BANK PROTECTION (SOIL CEMENT)	2
BP - BANK PROTECTION (GOBI MAT)	1
BP - BANK PROTECTION (WILLOWS)	1
BP - BANK PROTECTION (TIRE MATTRESSES)	1
BP - BANK PROTECTION (WIRE ENCASED RIPRAP)	1
BP - BANK PROTECTION (SHEET PILE)	1
BP - BANK PROTECTION (CRIBS)	3
BP - BANK PROTECTION (HYDROLINE MATTING)	1
BP - BANK PROTECTION (FABRIFORM)	1
BP - BANK PROTECTION (ROCK SAUSAGES)	1
BP - BANK PROTECTION (DOUBLEWALL)	1
BP - BANK PROTECTION (MIRAMAT/ ENKMAT)	1
BP - BANK PROTECTION (PAVING BLOCK)	1
BM - BASIN MODIFICATIONS/ MANAGEMENT	2
CS - CLEARING AND SNAGGING	24
DB - DEBRIS BASINS, SEDIMENT TRAPS	8
DI - DIVERSION INTO CHANNELS	11
DO - DIVERSION OUT OF CHANNELS	13
DR - DREDGING	9
DE - DEEPENING	14
EN - GENERAL ENLARGING, "IMPROVEMENT"	33
EV - ENVIRONMENTAL FEATURES	11
EX - SELECTIVE EXCAVATION	27
FC - FLOW CONTROL, FLOOD CONTROL DAMS	12
GC - GRADE CONTROL, DROPS, WEIRS, SILLS	17
HI - HIGH FLOW CHANNEL, COMPLEX GEOMETRY	12
LV - LEVEES, FLOODWALLS, DIKES	32
PI - PILOT CHANNELS	12
RE - RECREATIONAL FEATURES	4
RT - TRANSITION STRUCTURES/FEATURES	5
SH - SHORTENING, CUTOFFS, STRAIGHTENING	23
SU - SURFACING, PAVING, CONCRETE CHANNEL	10
TR - RIVER TRAINING STRUCTURES	8
XC - AUXILLIARY CHANNEL/ NEW CHANNEL	5
OO - OTHER (LANDSIDE FILL)	1
OO - OTHER (DETENTION BASINS)	5
OO - OTHER (CONDUITS,SIPHONS,ETC.)	3
OO - OTHER (DAM REMOVAL)	1
OO - OTHER (FLOODPROOFING)	2

(Continued)

(Sheet 3 of 10)

Table D2 (Continued)

QUESTION 3. POST CONSTRUCTION PROBLEMS	
AGGRADATION/DEPOSITION/SEDIMENTATION, GENERAL	24
BANK FAILURE SLOUGHING, SLIDING, ETC.	23
DEBRIS ATTACK & JAMS	4
DEGRADATION/SCOUR, GENERAL	18
DEPOSITION, LOCAL (BARS,MOUTH,JUNCTION)	8
DIVERSION CHANNEL PROBLEMS	1
ENVIRONMENTAL PROBLEMS	3
EROSION OF CONCRETE	1
FILTER FABRIC CLOGGING/ FAILURE	1
FLANKING OF STRUCTURES	5
FLOOD HEIGHT INCREASE UPSTREAM	1
GABION FAILURE (WEAR,UNDERMINING,ETC.)	8
HEADCUTTING	6
ICE ATTACK & JAMS	3
INSTABILITY, GENERAL	9
LEVEE OVERTOPPING, TIEBACK	1
LEVEES FAIL, OLDER	8
LOW FLOW CHANNEL MEANDERING OR SILTING	9
MISOPERATION OF STRUCTURES	1
REGIME ALTERATION	7
RIPRAP FAILURE (FOR WHATEVER REASON - SEE BELOW)	18
SCOUR, LOCAL	6
STRUCTURAL FAILURE	1
TIDAL ACTION	3
TOE ATTACK, SCOUR FROM BRAIDED STREAMS	8
TOE ATTACK, SCOUR FROM MEANDERING STREAMS	21
TRANSITION DESIGN INADEQUATE	4
VEGETATIVE CLOGGING/CHOKING	7
WAVE ATTACK	4
WIDENING	4

QUESTION 5. CRITERIA NEEDS (SEE SPECIAL TOPICS ALSO)	
AERIAL PHOTO INTERPRETATION	1
BACKFILL REQUIREMENTS FOR PL 99	1
BANK PROTECTION METHODS, VARIETY	13
BRIDGE OPENING CRITERIA	4
CHANNEL DESIGN, GRASS LINED	2
CHANNELIZATION EFFECTS ON FISH	1
CHANNELIZATION GUIDANCE, PRACTICAL, CHECKLIST	5
COHESIVE SOIL STABILITY	2
CRIB WALL DESIGN	1
DATA BASE ON DIFFERENT DESIGNS/ INTER-COMMUNICATION	4
DEBRIS/DETENTION BASIN/TRAP DESIGN	4
DEWATERING A BASIN	1
DOWNSTREAM EFFECTS OF FLOW CONTROL	4
EAST COAST SHORE PROTECTION MANUAL (LOW ENERGY ENVRO)	1

(Continued)

(Sheet 4 of 10)

Table D2 (Continued)

ENVIRONMENTAL FEATURE EFFECTS ON HYDRAULICS	1
EXTREME EVENT FLOW LINE EXTRAPOLATION	2
FILTER FABRIC USE	3
FILTER MATERIAL/BEDDING	2
FLOATING MATS	1
FLOODPROOFING	1
GABION USE AND LIMITATIONS	7
GATE OPERATION, ONE GATE	1
GATES, FLAP HEAD LOSS	1
GRADATIONS FOR DIKES AND GROINS	1
GRADE DETERMINATION, STABLE	3
GRAVEL BED STREAMS	1
GRAVEL YIELDS, SAFE	1
GROINS AND BANK PROTECTION	3
GROUTED RIPRAP DESIGN GUIDANCE	5
HARDPOINT DESIGN	1
HEC-6 SIMPLIFIED/ SIMPLE TRANSPORT MODELS	8
HYDROLOGY/HYDRAULICS ESTIMATE WITH LIMITED DATA	1
ICE/DEBRIS HYDRAULIC ANALYSIS	2
INEXPENSIVE SOLUTIONS TO COMMON PROBLEMS	2
INTERIOR DRAINAGE REQUIREMENTS OFTEN TOO CUMBERSOME	4
LEVEE FAILURE, OLDER LEVEES, REHABILITATION	3
LEVEE FREEBOARD GUIDANCE	6
LOW FLOW/ ENVIRONMENTAL/ PILOT CHANNELS	5
LOW HEAD STRUCTURE ENERGY DISSIPATERS	1
LOW WATER CROSSINGS	1
MANUAL PRECEDENCE AND APPLICABILITY	3
MEANDER LOOPS OPEN FOR LOW FLOW	1
PUMP ROUTING PROGRAM	1
RECONNAISSANCE, ONE DAY, GUIDANCE	4
REVETMENT, NON-CONTINUOUS EFFECTS	1
RIPRAP SIZING FOR FLOW DOWN FACE/OVERTOPPING	1
ROUGHNESS IN ALLUVIAL CHANNELS	4
ROUGHNESS OF CONCRETE, SURFACE,BENDS,INLETS	2
SAMPLING SEDIMENT, LOAD ESTIMATION	1
SCOUR, LOCAL PREDICTION	5
SCOUR, LOW VELOCITY	1
SEC. 32 RE-EVALUATION/ OTHER DEMO PROJECTS	6
SEDIMENT MANUAL, EXPEDITE/ SEDIMENT STUDIES	2
SEDIMENT TRANSPORT ANALYSIS, HEAVY LOAD STREAMS	1
SEDIMENT YIELD & ANALYSIS, EPHEMERAL/URBAN STREAMS	3
SENSITIVITY ANALYSIS	1
SIDE DRAINAGE ENERGY DISSIPATORS/ INLET DESIGN	3
SIDE SLOPE STABILITY ANALYSIS/ BANK FAILURE MECHANISMS	3
SIPHON DESIGN	1
SOIL CEMENT AND RCC	2
STABILITY ANALYSIS, GENERAL / REGIME ANALYSIS	7
STILLING BASINS, TRAPEZOIDAL	1
SUMP DESIGN, PUMPING STATION	1
SUPERCRITICAL CHANNELS WITH OVERBANK SUBCRITICAL	1

(Continued)

(Sheet 5 of 10)

Table D2 (Continued)

TIDAL EFFECTS IN CHANNEL DESIGN	1
TRAINING METHODS/MEANDERS, RIVER	3
TRANSITION DESIGN/ TIE IN OF REVETMENT	9
VEGETATIVE COVER INFORMATION	1
VERIFY MODEL STUDY RESULTS	1
WAVE RUN UP	2
WES MODELLING COSTS AND TIME/ RESULTS NOT DEVELOPED	5

------S P E C I A L T O P I C S------

R I P R A P

FAILURE CAUSES

BANK SLOUGHING/ FOUNDATIONAL FAILURE/ UPLIFT	10
BEDDING POOR	2
CHANNEL CLOGGING SPEEDS OR ANGLES FLOW	2
DEBRIS ATTACK	1
DREDGING NEAR TOE	1
FABRIC SLIDING, CLOGGING, OR FAILURE	9
FLANKING	8
FLOW DOWN THE STONE FACE/BEHIND OR ABOVE STONE TOP	6
GATE OR OTHER STRUCTURE OPERATION FAULTY	4
ICE ATTACK OR PLUCKING	6
MAINTENANCE LACK	1
PLACEMENT/QUALITY CONTROL POOR	5
SCOUR AROUND/BELOW STRUCTURES	7
SCOUR FROM ANGLED FLOW INTO BANK (MEANDERS,BRAIDS,ETC.)	20
SCOUR, GENERAL ALONG TOE	16
SEEPAGE EXIT	2
SIZE INADEQUATE	5
SIZE INADEQUATE, OLDER SITE	5
SIZES/GRADADATIONS NOT AVAILABLE OR NOT USED	11
TRANSITION DESIGN	7
VANDALISM	5
WAVE ATTACK, WIND, NAVIGATION, PROP WASH	8
WEATHERING, POOR STONE QUALITY	5

(Continued)

(Sheet 6 of 10)

Table D2 (Continued)

OTHER METHODS USED	
BUREAU OF PUBLIC ROADS METHOD	1
OUR OWN SIZING METHOD	4
OUR OWN SPECIFIED GRADATIONS	9
OUR OWN VELOCITY DETERMINATION METHOD	1
OUR OWN THICKNESS SPECIFICATION IN BASINS	1
SHORE PROTECTION MANUAL	3
SORENSON PAPER	1
CORPS PROGRAM H7011	1
RIPRAP RELATED RESEARCH/GUIDANCE NEEDED	
ANGLED FLOW METHODS/ BETTER BEND ADJUSTMENT	7
CONCRETE BLOCK MATS	2
CONSTRUCTION TECHNIQUES INPROVED	1
D50 MIN OR MAX WHEN TO USE/ SAFETY FACTORS TO USE	3
EM METHOD NOT ALWAYS APPROPRIATE, OVERDESIGN (?)	20
END PROTECTION AND DESIGN	1
EXTENT UP AND DOWNSTREAM	4
FILTER CLOTH/FABRIC USE	4
FILTER/FOUNDATIONAL DESIGN	3
GRADATIONS, STANDARD, EASE THE CRITERIA	13
GRAVEL AND SMALL SIZE USE	2
GROINS, EFFECT ON SIZING BETWEEN	1
GUIDE SPECIFICATION ON STONE TO USE	4
HDC METHOD INFLEXIBLE	1
ICE ATTACK DESIGN	2
LAUNCHED RIPRAP/RIPRAP TOE, WINDROW REVETMENT	2
MANUAL, ONE COMPREHENSIVE, COVERS ALL CASES	9
METHOD PREFERENCES	6
MODEL, WHEN NEEDED/ BETTER REPORTING	2
MODELLING AT FULL SCALE	1
PROP AND BARGE WASH SIZING	3
QUALITY CONTROL	1
RISK BASED DESIGN	1
ROUGHNESS TO USE FOR SIZING	1
SHAPE EFFECTS (COBBLES)	1
SHORE PROTECTION Kd FACTORS	1
SIZING DURING LEVEE DESIGN	2
SIZING NEAR STRUCTURES/PIERS	2
STEEP STREAM AND/OR SMALL DITCH PROTECTION	5
STILLING BASIN SIZING	2
THICKNESS EFFECTS AND ADJUSTMENTS	4
TOE DEPTH AND DESIGN CRITERIA, ALL CASES	8
TOPSOIL AND SEEDING ON RIPRAP	2

(Continued)

(Sheet 7 of 10)

TRAINING COURSE FOR INSPECTORS	1
UNDERWATER/TURBULENT EMPLACEMENT	3
UP SLOPE DISTANCE CRITERIA	2
VEGETATION EFFECTS ON RIPRAP	4
VELOCITY, WHICH VELOCITY TO USE	9

GRADE CONTROL

GRADE CONTROL RESEARCH/GUIDANCE NEEDED

COMPHEHENSIVE CRITERIA NEEDED	6
COMPLEX CREST SECTION	1
DASHED LINE EXTENSION ON CIT TYPE STRUCTURES IN HDC	1
DOWNSTREAM SCOUR	2
HEADCUTTING	2
HEIGHT LIMITATIONS	1
INEXPENSIVE DROP STRUCTURES NEEDED	4
ROCK DROP STRUCTURES	1
ROCK OR OTHER BASIN DESIGN	4
SAFETY FEATURES	4
SEDIMENTATION PROBLEMS	4
SHEET PILE DESIGN AND ENERGY DROP OVER IT	2
SLOPE STABILITY BETWEEN STRUCTURES/BEST SLOPE	5
SPACING	3
STRUCTURE, DIFFERENT TYPES	2
SUBMERGENCE CURVE FOR STRAIGHT DROP STRUCTURE	1

MISCELLANEOUS EXPERTISE OR KNOWLEDGE

BANK FAILURE MECHANISMS	1
BRIDGE PLUGGING DESIGN CRITERIA	1
CHANNEL DESIGN, SMALL	1
CHECKLIST FOR ENVIRONMENTAL CONCERNS	1
CHECKLISTS FOR DESIGN AND REPORTING	1
CLEARING & SNAGGING	3
CRIBS	2
DAMS & OUTLET WORKS	1

(Continued)

(Sheet 8 of 10)

Table D2 (Continued)

DEBRIS JAMS	1
DEBRIS/RETENTION BASINS	3
DISCHARGE, DESIGN DETERMINATION	1
DOUBLEWALL, CONCRETE BLOCKS	1
DRIFT EMBANKMENT	1
DUMPING OF STONE IN HIGH WATER (PL99)	1
ENERGY DISSIPATION DEVICES	1
EROSION CONTROL	1
FABRIFORM	1
FILTER FABRIC	4
GABIONS	8
GOBI MAT	1
GRADE CONTROL	5
GROINS & DIKES	3
GROUTED STONE RIPRAP	3
H PILES	3
HYDROLINE MATTING	1
INTERIOR DRAINAGE	1
KELLNER JACKS	1
LEASED PUMP FOR FLOODING	1
LEVEE HEIGHT DETERMINATION	1
LOW FLOW CHANNELS	1
MEANDER MODELLING	1
MIRAMAT/ ENKMAT	1
MODELLING UNSTEADY FLOW	1
OTHER BANK PROTECTION METHODS	2
PUMPS, SUBMERSIBLE	1
REGIME ANALYSIS	1
RIPRAP	5
RIPRAP REHABILITATION	2
ROCK HARDPOINTS	1
ROCK SAUSAGES	1
ROCK SPECIFICATION	1
ROUGHNESS COEFFICIENTS	2
SCOUR PREDICTION	1
SEDIMENTATION STUDIES	2
SEEDING MIXTURE	1
SEEDING MIXTURE	1
SOIL CEMENT	4
STABLE CHANNEL DESIGN	6
SUPERCRITICAL CHANNELS	2
TIDAL EFFECTS	1
TRANSITION DESIGN	1
TRENCH/WINDROW REVETMENT	2
VELOCITY CRITERIA FOR CHANNEL DESIGN	3
VELOCITY DETERMINATION FOR RIPRAP DESIGN	1
WIRE ENCASED RIPRAP	1

(Continued)

Table D2 (Concluded)

E N V I R O N M E N T A L C O N C E R N S	
DESIGN FEATURES	
ARCHEOLOGICAL INVESTIGATIONS	1
BERM WIDTH/ BERMS	3
BOULDERS	4
CONSTRUCTION TIMING/ CONSTRUCTION LIMITATIONS	11
CRIBS	1
DEFLECTOR VANES	1
DETENTION STORAGE	1
DREDGED MATERIAL PLACEMENT RESTRICTIONS	2
EXCAVATE ONE SIDE ONLY	4
FISH PASSAGE SILLS, LADDERS, ETC.	2
FLOW MAINTENANCE	2
GRAVEL MINING, USEFULL, HAULTED	1
SOIL/GRAVEL/COBBLE SURFACING OF RIPRAP	3
GROINS & DIKES	3
LANDSCAPING	1
LOW FLOW/PILOT/ENVIRONMENTAL CHANNELS	5
MAINTAIN MEANDER LOOPS	2
MATERIAL USE LIMITATIONS	1
MITIGATION AREA/ WILDLIFE HABITAT AREA	8
MULTI-LEVEL INTAKES	1
NOTCHED DROP STRUCTURES	2
NOTCHED JETTY	1
POOL AND RIFFLE	2
REVEGETATION	5
REVETMENT LIMITATION	2
SHELVES	1
SILT FENCES	1
V SHAPED CHANNEL	1
VEGETATION SAVING	13
WIERS	3
P R O J E C T R E V I E W	
COMMON REVIEWER COMMENTS	
ECONOMIC ANALYSIS CHANGES	1
EFFECT OF FLOWS LARGER THAN DESIGN	2
FEATURE OMITTED OR UNDER DESIGNED	5
LACK OF DETAILED INFORMATION FOR INDEPENDENT ASSESSMENT	8
OUTDATED OR INCORRECT MANUALS OR GUIDANCE USED	9
REAL ESTATE DOCUMENTATION LACK	1
REDUCE HIGH COSTS OF RIPRAP AND BRIDGE MOD.	1
REQUIRE MORE OR DIFFERENT ALTERNATIVES	3
SEDIMENT ANALYSIS/ CHANNEL STABILITY INADEQUATE	7
SENSITIVITY ANALYSIS REQUIRED	1
WHY CHANGE DESIGN DURING PHASES	1

(Sheet 10 of 10)

Table D3

Lower Mississippi Valley Division Summary

Improvement Method*	Stream Type*																	
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	
AL						2													2
BPRR											1								1
BFGB																			0
BFOD																			0
BM																			0
CS			5			18	28					2							53
DB																			0
DI																			0
DO						4	1												5
DR																			0
DE																			0
EN			35			10	16												61
EV																			0
EX						2													2
FC																			0
GC						1	3				1								5
HI							1				1								2
LV			16			8	20				5								49
PI																			0
RE																			0
RT																			0
SH	1	1	27			2	14			1	4	2							52
SU							2												2
TR																			0
XC			1																1
001			5				1												6

Note: Includes projects from project map book only.
* See Appendix A

Table D4

Missouri River Division Summary

Improvement Method*		Stream Type*																	
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	
AL		3	3			6	6					1							19
BPRR		2	2		1	2	1	1				2	1						12
BPGB																			0
BPOO												1							1
BM																			0
CS		5	2			3	1					1							12
DB											1								1
DI		1			1														2
DO		1	5				5					1	1						13
DR																			0
DE																			0
EN		7	8		1	7	1				3		1						28
EV																			0
EX		3			1	2													6
FC		1				2	1				1								5
GC		2	2		1	2	1					1	1						10
HI		1	3			1													5
LV		12	10		1	15	16	1			3	8	1						67
PI		1	1		1														3
RE																			0
RT																			0
SH		8	7			7	2					2							26
SU					1						1	1							3
TR		1																	1
XC					1		3					1							5
001																			0

Note: Includes projects from project map book only.
* See Appendix A

Table D5

North Atlantic Division Summary

Improvement Method*	Stream Type*																		
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	HAL	TID	
AL						3		1	5		2	2							13
BPRR		4			1	3	1		2	1	2	1					1	1	17
BPGB		1										1							2
BPOO																			0
BM																			0
CS	1	3	1		1	2		3	4		5	4					8	1	33
DB			1			1													2
DI									1										1
DO									1	1								1	3
DR			2	1														5	8
DE								1			1								2
EN	1	4		1	1	2	1					1					1		12
EV									2										2
EX		1						1	3		4	4							13
FC		1				1		1			2								5
GC						2					2	1							5
HI		2						1	1										4
LV	1	5			1	7	7	1	5	2	5	8					8		50
PI					1			1											2
RE																			0
RT																			0
SH		2		1					1			1						3	8
SU	1	1			1	1				1	3	1					8		17
TR																		2	2
XC																		1	1
OO1						1				1	1								3

Note: Includes projects from project map book only.
* See Appendix A

Table D6

North Central Division Summary

Improvement Method*	Stream Type*																	
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	
AL		5	2			5	1	1											14
BPRR		6	5			5	10	5	3								1		35
BPGB																			0
BPOO		2						1											3
BM																			0
CS		6	7			2	4					1							20
DB							3												3
DI		3	2					1									1		7
DO		5	1			1	2										2		11
DR		1																	1
DE			1			2		1											4
EN		13	13	1		4	8	2	2										43
EV		1																	1
EX		1		1		4													6
FC		2				4	2	1											9
GC		4	7			2	2	3									2		20
HI		1	3				1												5
LV		15	18	2	1	10	11	3	2								3		65
PI																			0
RE							1												1
RT																			0
SH		7	8	1		5		1	1										23
SU		2				4	3												9
TR																			0
XC		1	1	1	1				2										6
001		2	1			1													4

Note: Numerous older levee projects not recorded. Includes projects from project map book only.
* See Appendix A

Table D7

New England Division Summary

	Stream Type*																	
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	
AL		1					1				1								3
BPRR		2	1			3	5				6	1							18
BPGB																			0
BPOO																			0
BM																			0
CS		1					1				1								3
DB																			0
DI																			0
DO			1			2					1								4
DR																			0
DE																			0
EN						3	3				4								10
EV							2						1						3
EX							4				1								5
FC						2	2						1						5
GC			1			1	1				1								4
HI						1	1												2
LV		5	1		1	4	3				9		1						24
PI						1													1
RE						1													1
RT																			0
SH			1				2				1								4
SU		1																	1
TR																			0
XC		1	1			1													3
001						2	2												4

(Row labels: Improvement Method*)

Note: Includes projects from project map book only.
* See Appendix A

Table D8

North Pacific Division Summary

Improvement Method*							Stream Type*												
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	
AL						1	1				1	1	2						6
BPRR	1	4	1		2	2	6	1	2	1	8	16	6						50
BPGB																			0
BPOO																			0
BN																			0
CS					1	1		1	1		1	2	1						8
DB																			0
DI													1						1
DO	1				1	1						1	1				1		6
DR													1						1
DE																			0
EN	1	2			1	1	2	1			3	3							14
EV																			0
EX		1									1	1							3
FC			1																1
GC	1											1	1						3
HI																			0
LV		5	2		3		7	1	1	1	8	14	5						47
PI													1						1
RE			1																1
RT																			0
SH		1			2	2						2	3						10
SU	1				1		1						1				1		5
TR			1				1					2	2						6
XC			1			1				1		1							4
001																	1		1

Note: Includes projects from project map book only.
* See Appendix A

Table D9

Ohio River Division Summary

Improvement Method* / Stream Type*

000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	
AL		1	3			1	1												6
BPRR	1	6	6			11	3	2			4						2		35
BPGB																	1		1
BPOO																			0
BM			1																1
CS	1	3	6			3	1				1								15
DB		1				1					1								3
DI		2																	2
DO		2	1																3
DR																			0
DE																	1		1
EN		11	9			16	4	1			4						2		47
EV		1						1											2
EX		1	3				2												6
FC		1																	1
GC	1	2	3			2		1			4								13
HI		1	2														1		4
LV	1	4	8			5	4	1			3								26
PI		1				2													3
RE						1													1
RT																			0
SH		9	7			8	2										2		28
SU	1	1	1			2											1		6
TR			1				1												2
XC		1																	1
001								1			1								2

Note: Includes projects from project map book only.
* See Appendix A

Table D10

South Atlantic Division

Improvement Method*	Stream Type*																	
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	
AL		1	4	1		5	3												14
BPRR							3												3
BPGB																			0
BPOO							1												1
BN																			0
CS		1	19	2	1	10	24												57
DB		1																	1
DI		5	2																7
DO		5	2				1												8
DR																			0
DE																			0
EN	1	4	18	1		6	10										1		41
EV	1																		1
EX		3	4	2		5	11												25
FC		7	6				1												14
GC			1				1												2
HI			1					1											2
LV		3	5				4	3											15
PI																			0
RE																			0
RT																			0
SH		1	1			1	3												6
SU		1					2												3
TR			1																1
XC		5	3				1												9
OO1																			0

Note: Includes projects from project map book only.
* See Appendix A

Table D11

South Pacific Division

Improvement Method*	Stream Type*																		
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	
AL		1			1	3		1			1								7
BPRR		3		1	1	8	4	7	1		3		1		5	13	1		48
BPGB																	2		2
BPOO						1		1											2
BM																			0
CS						2	1	1	1				1		2				8
DB															4	9			13
DI		1			1	2										1			5
DO					1	3	1			1	1				3	1			11
DR																			0
DE				1															1
EN		3		1	2	10	1	3							3				23
EV		1				1	1												3
EX					2			3			1				1	1			8
FC		2			1	4	1	2							1				11
GC		1				2	1	1		1					1	6			13
HI								1								5			6
LV		4		1	3	5	3	7	2		4		1		7	2	1		40
PI							1	1	1										3
RE						2		3							2				7
RT						2									6				8
SH		1			1	2		1			1								6
SU		1		1	1	7	1	1							10	58	1		81
TR						1		1	2						3	1	1		9
XC		2			1	3	2	2		1	1				3	1			16
OO1						3		1							2				6

Note: Includes projects from project map book only.
* See Appendix A

Table D12

Southwestern Division Summary

Improvement Method*	Stream Type*																	
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	
AL				3			1												4
BPRR			1	3	1	2	4				1					6			18
BPGB																			0
BPOO																			0
BK																			0
CS	1		2				6				1								10
DB																			0
DI																			0
DO			1				2									6			9
DR																			0
DE																			0
EN	1		2	3	1	2	9	2			2	1						1	24
EV																			0
EX				1			1	2											4
FC																3			3
GC			1				1									1		1	4
HI				1															1
LV			1	7		1	6	2											17
PI																			0
RE																			0
RT																			0
SH					1	3	4				1	1							10
SU					1	2	2									6	1	1	13
TR				3															3
XC							1									6	1		8
001																2			2

Note: Includes projects from project map book only.
* See Appendix A

Table D13

Total of All Divisions

Improvement Method*	Stream Type*																		
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	HAL	TID	
AL	0	12	12	4	1	26	14	3	5	0	5	4	2	0	0	0	0	0	88
BPRR	2	27	16	4	6	36	37	16	8	2	24	20	8	0	5	19	5	1	236
BPGB	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	5
BPOO	0	2	0	0	0	1	1	2	0	0	0	1	0	0	0	0	0	0	7
BM	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
CS	3	19	42	2	3	41	66	5	6	0	9	10	2	0	2	0	8	1	219
DB	0	2	1	0	0	2	3	0	0	0	2	0	0	0	4	9	0	0	23
DI	0	12	4	0	2	2	0	1	1	0	0	0	1	0	0	1	1	0	25
DO	1	13	11	0	2	11	12	0	1	2	2	2	2	0	3	7	3	1	73
DR	0	1	2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	5	10
DE	0	0	1	1	0	2	0	2	0	0	1	0	0	0	0	0	1	0	8
EN	4	44	85	7	6	61	55	9	2	0	16	5	1	0	3	0	4	1	303
EV	1	3	0	0	0	1	3	1	2	0	0	0	1	0	0	0	0	0	12
EX	0	10	7	4	3	13	18	6	3	0	7	5	0	0	1	1	0	0	78
FC	0	14	7	0	1	13	7	4	0	0	3	0	1	0	1	3	0	0	54
GC	2	9	15	0	1	12	10	5	0	1	8	3	2	0	1	7	2	1	79
HI	0	5	9	1	0	2	3	3	1	0	1	0	0	0	0	5	1	0	31
LV	2	53	61	10	10	55	81	19	10	3	37	30	8	0	7	2	12	0	400
PI	0	2	1	0	2	3	1	2	1	0	0	0	1	0	0	0	0	0	13
RE	0	0	1	0	0	4	1	3	0	0	0	0	0	0	2	0	0	0	11
RT	0	0	0	0	0	2	0	0	0	0	0	0	0	0	6	0	0	0	8
SH	1	30	51	2	4	30	27	2	2	1	7	8	3	0	0	0	2	3	173
SU	3	7	1	1	5	16	11	1	0	1	4	2	1	0	10	64	12	1	140
TR	0	1	3	3	0	1	2	1	2	0	0	2	2	0	3	1	1	2	24
XC	0	10	7	1	3	5	7	2	2	2	1	2	0	0	3	7	1	1	54
OO1	0	2	6	0	0	7	3	2	0	1	2	0	0	0	2	2	1	0	28
	19	279	344	41	49	346	362	89	46	13	129	95	36	0	53	128	57	17	

Note: Numerous Sec. 14 Bank Protection Projects and older levee projects not included. Includes projects for project map book only.

* See Appendix A

Table D14

Total of All Divisions as a Percent

Improvement Method*	Stream Type*																		
000	S1	S2	S3	S4	M1	M2	M3	M4	M5	B1	B2	B3	B4	B5	FAN	ARR	NAL	TID	TOTAL
AL	0.0	4.3	3.5	9.8	2.0	7.5	3.9	3.4	10.9	0.0	3.9	4.2	5.6	0.0	0.0	0.0	0.0	0.0	4.2
BPRR	10.5	9.7	4.7	9.8	12.2	10.4	10.2	18.0	17.4	15.4	18.6	21.1	22.2	0.0	9.4	14.8	8.8	5.9	11.2
BPGB	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	5.3	0.0	0.2
BPOO	0.0	0.7	0.0	0.0	0.0	0.3	0.3	2.2	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
BM	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.0
CS	15.8	6.8	12.2	4.9	6.1	11.8	18.2	5.6	13.0	0.0	7.0	10.5	5.6	0.0	3.8	0.0	14.0	5.9	10.4
DB	0.0	0.7	0.3	0.0	0.0	0.6	0.8	0.0	0.0	0.0	1.6	0.0	0.0	0.0	7.5	7.0	0.0	0.0	1.1
DI	0.0	4.3	1.2	0.0	4.1	0.6	0.0	1.1	2.2	0.0	0.0	0.0	2.8	0.0	0.0	0.8	1.8	0.0	1.2
DO	5.3	4.7	3.2	0.0	4.1	3.2	3.3	0.0	2.2	15.4	1.6	2.1	5.6	0.0	5.7	5.5	5.3	5.9	3.5
DR	0.0	0.4	0.6	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	29.4	0.5
DE	0.0	0.0	0.3	2.4	0.0	0.6	0.0	2.2	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.4
EN	21.1	15.8	24.7	17.1	12.2	17.6	15.2	10.1	4.3	0.0	12.4	5.3	2.8	0.0	5.7	0.0	7.0	5.9	14.4
EV	5.3	1.1	0.0	0.0	0.0	0.3	0.8	1.1	4.3	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.6
EX	0.0	3.6	2.0	9.8	6.1	3.8	5.0	6.7	6.5	0.0	5.4	5.3	0.0	0.0	1.9	0.8	0.0	0.0	3.7
FC	0.0	5.0	2.0	0.0	2.0	3.8	1.9	4.5	0.0	0.0	2.3	0.0	2.8	0.0	1.9	2.3	0.0	0.0	2.6
GC	10.5	3.2	4.4	0.0	2.0	3.5	2.8	5.6	0.0	7.7	6.2	3.2	5.6	0.0	1.9	5.5	3.5	5.9	3.8
HI	0.0	1.8	2.6	2.4	0.0	0.6	0.8	3.4	2.2	0.0	0.8	0.0	0.0	0.0	0.0	3.9	1.8	0.0	1.5
LV	10.5	19.0	17.7	24.4	20.4	15.9	22.4	21.3	21.7	23.1	28.7	31.6	22.2	0.0	13.2	1.6	21.1	0.0	19.0
PI	0.0	0.7	0.3	0.0	4.1	0.9	0.3	2.2	2.2	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.6
RE	0.0	0.0	0.3	0.0	0.0	1.2	0.3	3.4	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.5
RT	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	11.3	0.0	0.0	0.0	0.4
SH	5.3	10.8	14.8	4.9	8.2	8.7	7.5	2.2	4.3	7.7	5.4	8.4	8.3	0.0	0.0	0.0	3.5	17.6	8.2
SU	15.8	2.5	0.3	2.4	10.2	4.6	3.0	1.1	0.0	7.7	3.1	2.1	2.8	0.0	18.9	50.0	21.1	5.9	6.7
TR	0.0	0.4	0.9	7.3	0.0	0.3	0.6	1.1	4.3	0.0	0.0	2.1	5.6	0.0	5.7	0.8	1.8	11.8	1.1
XC	0.0	3.6	2.0	2.4	6.1	1.4	1.9	2.2	4.3	15.4	0.8	2.1	0.0	0.0	5.7	5.5	1.8	5.9	2.6
OOI	0.0	0.7	1.7	0.0	0.0	2.0	0.8	2.2	0.0	7.7	1.6	0.0	0.0	0.0	3.8	1.6	1.8	0.0	1.3
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	100.0	100.6	100.0

* See Appendix A

APPENDIX E: MISCELLANEOUS EXPERTISE

Introduction

1. This appendix lists (a) subjects in which a District or Division felt they had some expertise; and (b) uncommon hydraulic design methods or practices of general interest. This list includes only those methods mentioned by the inventory participants. Reports, papers, and other sources* referenced in this appendix are only peripherally applicable to the design of stable channels in natural materials. References of general interest are included in the main body of the report.

Division Summaries

Lower Mississippi Valley Division

2. Memphis. Sediment monitoring programs, general semiquantitative sediment and stability studies.

3. St. Louis. A systems analysis approach to channel assessment and design.

4. Vicksburg. Expertise in a wide variety of bank protection and grade control structures. Have used a number of channel stability analysis tools and methods. Experienced in the use of the geomorphic approach to channel design or analysis.

Missouri River Division

5. The Division has experience in the use of grade control and drop structures (Gering Valley) and recently has been in contact with the Iowa Institute of Hydraulic Research, University of Iowa, Iowa City, Iowa, concerning the use of Iowa vanes.

6. Kansas City. Experience in the design of stable channels and their analysis as well as bank protection and erosion control.

7. Omaha. Experienced with dumped stone revetment, windrow revetments, and cover stone techniques for riprap rehabilitation.

New England Division

8. Experience in handling ice problems with riprap (normally increase thickness by 50 percent) and the use of "doublewall" (a series of bottomless,

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* In some cases, complete and accurate information on all references was not supplied.

rectangular-shaped bins filled with stone and placed along a river bank to serve both as a retaining wall and an erosion control measure) for bank protection. Have own riprap design method based on a nomographic development of the original shear equations.

North Atlantic Division

9. Experience in large detention dams and in diversion tunnel design.

10. New York. Have own riprap design method worksheet which loosely follows the shear concept.

11. Norfolk. Experience in shore protection, floating mats, and channel dredging.

12. Philadelphia. Experience in gabion design for bank protection. Have found the following publication useful for fabric design and use: "Use of Engineering Fabrics in Transportation-Related Applications."*

North Central Division

13. Buffalo. Use the Baker and Ritter equation for sediment considerations with some success. Have a sediment investigation (stability analysis) checklist. Have special expertise in riprap design and the analysis of riprap stone quality and how to obtain optimum quality from a given quarry.

14. Detroit. Experience in the use of a vegetative seeding mixture and placement method for bank stabilization. It thrives well both under and above water. Have also a unique drop structure design with nonsymmetric basin and approaches.

15. Rock Island. Use Lane equation and Froude number methods for approximate stability analysis. Use state gradations for riprap design. Experience in repair of levees built of sand and other noncohesive materials.

16. St. Paul. Have own method for analysis of possibilities of bridge plugging along with a checklist. Have designed drop structures to match existing rating curves by using complex overflows.

North Pacific Division

17. Alaska. Experience in stream monitoring (Tanana) and in-stream gravel extraction limitations. Have also had special experience in river

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* T. Allan Haliburton, Jack D. Lawmaster, and Verne C. McGuffey. 1981. "Use of Engineering Fabrics in Transportation-Related Applications," prepared for Federal Highway Administration under Contract No. DTFH61-80-C-00094 by Haliburton Associates, Stillwater, OK.

training structures. Use special guidance in river analysis from Delft*. Use the Vicksburg District gradations for riprap. For scour around spur dikes, they use papers by Garde, Subramanya, and Nambudripad** and by Gill.†

18. Portland. Use a type of groinlike structure called a drift embankment. Riprap is plated to flatten and improve interlocking of stone. Use locally developed riprap gradation criteria with five classifications. Also, use a paper by Sorenson†† for riprap design for toe wave attack. Have also established maintenance standards for levees and riprap.

19. Seattle. Have riprap design method based on empirical evidence from Pacific Northwest streams. Have special experience in the design of debris basins (Tatum approach).

Ohio River Division

20. Division Laboratory. Has expertise in testing rack for weathering characteristics.

21. Huntington. Specialized technique for extrapolating to standard project flood developed in conjunction with US Army Engineer Waterways Experiment Station. Have expertise in the analysis of bank failure mechanisms and how to perform field reconnaissance of same.

22. Louisville. Experience with log jams and H-piles with lagging.

23. Nashville. Experience in drop inlet and other related inlet type structures.

24. Pittsburgh. Experience in the use of Fabriform mattresses, rock sausages, grouted riprap, gabions, and grade control on supercritical flow streams. Have locally developed aids to riprap design, including estimates of Manning's n and identification of velocities.

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* van Berlekom. "Rivers," unpublished lecture notes, International Courses in Hydraulic and Sanitary Engineering, Delft, The Netherlands.

** R. J. Garde, K. Subramanya, and K. D. Nambudripad. 1961 (Nov). "Study of Scour Around Spur Dikes," Journal of the Hydraulics Division, American Society of Civil Engineers, Vol 87, No. HY6, pp 23-27.

† M. A. Gill. 1972 (Sep). "Erosion of Sand Beds Around Spur Dikes," Journal of the Hydraulics Division, American Society of Civil Engineers, Vol 98, No. HY9, pp 1587-1599.

†† R. M. Sorenson. 1973 (May). "Waterways Produced by Ships," Journal, Waterways, Harbors, and Coastal Engineering Division, American Society of Civil Engineers, Vol 94, No. WW2, p 245.

South Atlantic Division

25. Mobile. Experience with multiple sheet-pile drop structures, rock weirs, and baffled chutes.

26. Savannah. Experience with tidal effects, unsteady flow modeling, and permissible velocity designs.

South Pacific Division

27. Los Angeles. Expertise in debris basin design, grade control structures, river training structures, Enka Mat (proprietary name), transition design, supercritical channel design, soil cement, and bank protection. Have their own locally developed grading for riprap.

28. San Francisco. Have developed method for grade control stability analysis, which is a Froude number approach. Have a checklist for field reconnaissance. Special experience in the use of hardpoints.

Southwestern Division

29. Albuquerque. Experience with soil cement, wire-encased riprap, river training structures (dikes, groins, Kellner jacks), sedimentation basins, gabions, check dams, grouted riprap, and a number of different bank protection methods (Gobimats, cellular blocks, etc.). Have locally developed riprap gradation criteria.

30. Fort Worth. Have own hydrology program, NUDALLAS. Have experience in the design of drop structures coincident with road crossings.

APPENDIX F: FREQUENT COMMENTS BY REVIEWERS AT HEADQUARTERS, US ARMY CORPS OF ENGINEERS

1. Present and future imperviousness of the basin lands affects loss rates in the hydrology and needs support from land use and geology studies. Future land use with increased runoff should consider control of land use instead of accommodating the increase in the design.

2. Overbank lands needed for conveyance under design conditions should be controlled.

3. Channel stability considerations can be resolved through hardening, real estate acquisition, monitoring with future corrective actions, and changing secondary currents.

4. A project may be designed to protect against one source of flooding, but all sources of flooding must be considered in the justification and design of flood-control projects.

5. Coincidental frequency considerations are needed at all stream junctions.

6. Assumed timing of tributaries during future urbanization may require control to assure that timing of the tributaries will not occur in an adverse manner.

7. Federal Emergency Management Agency (FEMA) criteria allowing water rises due to encroachment (1-ft rise) should be incorporated in project performance and justification, and may require increased project design levels or local assurer control.

8. Ponding areas should consider restrictions to standard project flood (SPF) elevations to preclude unwise development of critical public services.

9. Closure structures (gates, openings, etc.) should consider warning devices as an adjunct to effect actions.

10. Initial overtopping locations(s) should consider real estate control to assure the viability of the location in the future.

11. Project openings in a levee can be permitted if volume of peak coming through these openings can be accommodated on the interior by features, real estate control, or items of local cooperation.

12. Railroad/highway grades, existing local levees, etc., used as tie-backs/tie-ins for project levees may need to be controlled; need to be part of the project description; meet Corps design standards; require some real estate taking; require operation and maintenance (O&M) money as part of project and must include freeboard.

13. Mannings' n coefficient of expansion and coefficient of

contraction may need to be preserved through the items of local cooperation.

14. Upstream reservoir holdouts (even if only surcharge) or downstream hydraulic controls separate from the project may need to be assured by local items of cooperation.

15. Repair, replacement, or maintenance of equipment or features may require extra real estate, special legal encumbrances, or special vendors not readily available in a timely manner or too costly. This should influence feature selection, adjuncts, and local requirements. Also, selection of design features requiring no repairs or no replacement is usually not correct. O&M must be workable and have a high probability of being performed by locals for the life of the project.

16. Control of 100-year flood conditions while allowing development and encroachment may worsen SPF conditions, i.e., consider full range of impacts.

17. All segments of a levee may not have the same overtopping catastrophe potential. Flank levees along large flashy tributaries may have worse potential catastrophe than main line of protection. Different levels of protection should be considered for those different segments.

18. Design flows for channel features must get into and stay in channel in project area.

19. Side drainage into channels should be controlled.

20. There is no one design discharge (or flood), rather different objectives for several floods.

21. Control water at upper end of channels and at tributaries.

  a. To get the water in.

  b. To prevent headcutting.

22. Extend profiles up and down from constriction to where project effects dampen out.

23. Interior flood-control pumps and other facilities must consider overland flow, ponding in streets, etc. There is no reason to limit pump capacity to sewer capacity.

24. Support level of protection with physical impacts of depth, velocity, debris, damages, areal extent of inundation, etc. Develop table (matrix) for several index stations.

25. Synthetic analyses of hydrology or hydraulics yield higher levels of uncertainty. To better understand and compensate for the uncertainty the design should consider the following:

a. Increase amount of sensitivity analysis.

b. Use conservative safety factors.

c. Increase contingency factor for both first cost and O&M.

26. Calibrating profiles to high water marks in a stage range with no velocity measurement to support the calculation of the flow may give false n values.

27. Bridges may need stability analysis to assure function during life of project for

a. Deck stability with underpinning

b. Scour of piers or abutments

c. Debris blockage with increased load across deck or sheer mass against the bridge causing potential failure of bridge

28. Water-Surface Profiles (WSP)

a. Is existing WSP calibrated from field measurements (make sure discharge measurement is made)?

b. Are starting water-surface elevations reasonable?

c. Use high n for stage considerations, low n for velocity considerations.

29. Are flooded-area maps (existing and improved conditions) provided? Profiles should include bank lines, invert, existing, and improvement conditions (but avoid crowding on the plate).

30. Project must function (not necessarily without damage) at most infrequent flood return interval for which stage reduction benefits are claimed.

31. Are in-place physical features used as part of flood-control plan? If so, they require same analysis as other project features and must meet Corps standards.

32. Channel freeboard may be as low as zero but must be supported by analysis of sensitivity, potential damages, etc.

33. Has channel stability been analyzed? Check for erodibles and/or silt strata, increased discharge due to loss of overbank storage, potential for rapid sediment infill of excavated channel enlargements.

34. Drop structure design.

a. Flanking (bank tie-in design)

b. Mistaken use of riprap for drops over 4 ft.

c. Must be located downstream of straight reach.

35. Estimates of debris production and blockage, and ice jam potential.

36. Riprap design using EM method. Problems with

a. Doubling safety factor on bends

b. Uses of D_{50} maximum and D_{50} minimum

c. Use of D_{50} as reference size

d. Toe design problems. Suggest use of informally furnished HQUSACE flow chart.

37. Freeboard design: overtopping design, no notches.

38. Tunnel design: steep upstream, flat downstream. Fills from downstream to upstream to avoid slug flow conditions.

39. Drawings are often unreadable!

40. Avoid rock-faced (only) spillways on earth embankment. NO fuseplug levees.

41. Problems with diversion structures.

a. Bed-load trapping.

b. Clear water scour of diversion channel.

42. Water-surface profile stability. Avoid $0.8 <$ Froude Number < 1.1.

43. Unsupported exotic analyses or solutions to flood-control problems will elicit unfavorable comments.

44. Model study requests need backup technical material.

45. Allowance for future conditions/channel encroachment/FEMA 100-year floodway.

46. O&M costs are often underestimated.

47. Wave computations for shallow-water conditions such as reservoirs.

48. Channel capacity maintenance, monitoring, and triggering criteria should be incorporated into items of local cooperation.

APPENDIX G: STREAMS RECOMMENDED FOR FURTHER STUDY

This appendix contains a table of those streams suggested by the Districts for possible further study. The streams were chosen as examples of successful or unsuccessful designs or for some other stream specific reason. The definitions of stream type and improvement method codes are given in Appendix A.

Table G1

Specific Streams for Further Study

DISTRICT	STREAM NAME	TYPE	IMPROVEMENT CODES & COMMENTS
LMM	St. Francis	M	CS,SH -SED MONITERING
LMM	L'Anguille	M	CS,EN,SH,GC - REGIME ANAL
LMM	Wolf River		SH,EN,CS -SELECTIVE C&S
LMM	Big Creek		CS -UNFORSEEN ENLARGEMENT'
LMK	Yalobusha	DELTA	SH,EN
LMK	Yocona		SH -BELOW RESERVOIR
LMK	L. Tallahatchi		SH
LMK	Tensas		EN -FILLING,SED. STUDY
LMK	Big Sand Cr.		GC,LV,EN -AGGRADING
LMK	Big & Colewa Cr	M2	SH,EN -FILLING
MRK	Soldier Cr.	S3	LV,AL,SH -X-SEC DATA
MRK	Little Blue Chnl	S2	AL,HI,DI,GC -RESPONSE
MRK	E. Fork 102 R.	S2,S3	CS,EN,SH -DEGRADATION
MRK	Chariton R.	S,M	SH,CS,EN,LV -WIDENING,MEANDER
MRK	Frankfort	S2	LV,AL,EN,GC -FILLING,DATA
MRO	Goering Valley		GC,HY,EN -GOOD DATA
MRO	N. Fork Elkhorn	M3	AL,LV,SH,GC -STABLE
MRO	Salt Cr. & Tribs	M2	CS,EN,LV,AL,FC -LEVEE SLUMP
MRO	Heart R.	M3	LV -ICE JAM,BACKWATER PROB.
MRO	Big Sioux	S3,M3	LV,EN,CS,DO -STABLE
MRO	Floyd R.	S3	SH,EN,LV,GC -DEGRADATION
MRO	Little Sioux R.	M2,S3	SH,EN,LV,GC -HEADCUT
MRO	L. Papillion Cr.	S2	EN,SH,BP,LV -STABLE
NED	Mad River	B2	EN -DAM REMOVAL,AGGRADATION
NED	Chicopee	S2	LV -BEND EROSION
NED	Northhampton	S3	LV,GC,BP,SH -BEND EROSION
NED	Three Rivers	M3	FC,EN, -DAM REMOVAL,DEGRADING
NED	Cocheco R.	B1,B2	LV,EN,AL,SH -DEGRADATION
NED	Woonsocket R.	M3	EN,LV,EX -RIPRAP FAILURE
NED	Nashua	S2	LV -GROUTED RIPRAP FAILURE
NAB	Elkland	B2,B3	LV,AL,CS -AGGRADATION
NAB	Hornell	B3	LV,AL,SU -AGGRADATION
NAN	Mt. Pleasant	B3	CS,EX,LV -TOE FAILURE
NAN	Ellenville	B1,B2	LV,SU,BP,DO -TOE FAILURE
NAN	Sawmill		CS,SU,LV -UNSTABLE,AGGRADATION
NAN	Herkimer	B3	LV,BP -ICE PROBLEMS
NAO	Vesuvius		EX -AGGRADATION
NAO	Meherrin	S4	SH,DR -LOG JAM PROBLEMS
NAP	Pocono Cr.	B	BP -GABIONS,BANK FAILURE

(Continued)

Table G1 (Continued)

DISTRICT	STREAM NAME	TYPE	IMPROVEMENT CODES & COMMENTS
NAP	Cape May		WAVE ATTACK EROSION
NAP	Equinunk		BEND EROSION
NCB	Cayuga Inlet	S2	BP,SH,EN,GC -HEADCUT
NCB	Wellsville	M4	GC,EN,BP -DETERIORATION,SED.
NCB	Mt. Morris Dam	M4	FC -ERO. & UNSTAB. DS OF DAM
NCB	Onandaga Dam	M2	AL,SH,GC,FC,BP,LV -SCOUR,UNSTAB.
NCB	Cayuga Cr.	M3	SU,EN,LV -SEDIMENTATION
NCC	Fox R.	S	DROPS,FINE SED.,INCISED
NCC	Des Plains	S2	LOW VEL. SCOUR, SLUMPING
NCC	Kankakee	M5	SEDIMENTATION,ICE JAMS
NCE	Flint	M3	EN,SU,GC -SPECIAL GRADE CONTROL
NCE	Estro		RODENTS & TREES CAUSED SCOUR
NCE	Rogue	S3	EN,SU,CS -VEGETATION
NCR	Blowers		GC,PI -HEADCUT,POOR TRANSITION
NCR	Sny	M3	FC,LV,DO,DB -BEND EROSION
NCR	Wapello		BANK CAVING
NCR	French & Dry Cr.	B3,M3	CS -AGGRADATION
NCR	Rock R.	M3	FC,CS,SH,SL -AGGRADATION
NCR	Farm Cr.	M2	FC,EN -AGGRADATION
NCR	Ackerman Cr.	M2	TOE SCOUR,AGGRADATION
NCS	Bonne Coulee	S2,S3	LV,BP,CS -SILTING
NCS	Minot	S3	CS,SH,GC,EN,LV,HI,BP -AGGRADING
NCS	Sand Hill	S2	EN,SH,CS,LV -SLUMP,MEANDERING
NCS	Wild Rice R.	S3	EN,SH,AL,CS,LV -WIDEN,ERO.,MEAN.
NCS	Lac Que Parle	M2	FC -SCOUR BELOW DAM
NCS	Miss. @ Elk R.	S2	LV,BP -FLANK RIPRAP
NCS	Rush Cr.	S3->S1.	EN,SH,CS,LV -BEND ERO.,FILLING
NCS	Zumbro R.	M1->M4	SU,LV,EN,BP -SILTING,MEANDERING
NPA	Chena Lakes	S3	FC,LV,RE,TR -DIVERSION
NPA	Tanana	B4,B2	TR,BP,LV,SH,AL,DI -GROINS
NPP	Salmon Cr.	B3	LV -MEANDERING
NPS	Fisher R.		GC
NPS	Clark Fork	B3	LV,BP -TREES IN RIPRAP
NPS	Green R.		BP -SEC. 32 PROJECT
NPW	Milton Freewater	B3	GC,LV,BP,SH,EN -SHIFT,MEANDERING
NPW	Lower Dry Cr.		EN,AL,LV,BP -DEGRADATION
NPW	Mill Cr.	B1,B4	LV,SU,SH,GC,BP -GRADE CONTROL
NPW	Salmon R.		LV,BP -ICE JAMS
NPW	Lower Malheuer		BP,LV -BANK ATTACK,MEAN.,CUTOFFS
NPW	Heise Roberts		CS,LV,AL,BP -UNSTABLE

(Continued)

(Sheet 2 of 4)

Table G1 (Continued)

DISTRICT	STREAM NAME	TYPE	IMPROVEMENT CODES & COMMENTS
NPW	Jackson Hole	B3,B4	LV,SH -DEGRADATION
ORH	Athens	M	SH,EN,AL,LV -SEDIMENTATION
ORH	Princeton	B	SH,EN -SEDIMENTATION
ORH	Matheny		ENV PROBLEMS,FILLING
ORH	Hughes Cr.		FILLING
ORH	Marsh Fork		BARS,SEDIMENTATION
ORH	Newark	B	LV,EN,SH,AL,GC -DROPS
ORL	Canoe Cr.		BANK SLOUGHING
ORL	Russel Levee		FOUNDATIONAL FAILURE
ORL	McAlpin Dam		ANGLED FLOW INTO BANK
ORL	Saline R.	S3	CS,EN,EX -BANK SLOUGHING
ORL	Lower Wabash R.		MEANDERING,UNSTABLE
ORL	Lick Cr.		LOG JAMS
ORN	Yellow Cr.	M	GC -HEADCUT,AGGRADING
ORN	White Oak Cr.	S2	EN
ORN	Burgess Cr.	M	GC,BP -GROUTED,GABIONS
ORP	Turtle Cr.	M2	EN,GC,LV,BP,SU,DB -SILTATION
ORP	Brookville	M2	EN,LV,BP,GC,PI -WELL TESTED
ORP	Dubois	S2	SH,EN,BP -BASIN CONST->FILLING
ORP	Youghiogheny	B2	EN,CS,BP -TOE EROSION
ORP	Tygart R.	S2	SH,LV,BP ,DO -FILLING
ORP	Chartiers Cr.	S3	EN,LV,SH,BP -TRANSITION FAIL
ORP	Woodcock		SPUR DIKES
SAC	Eagle Cr.	S2	EX -ALTERNATE SIDES,TIDAL
SAC	Shot Pouch Cr.	M2	CS -WELL MAINTAINED
SAC	Sawmill Br.	S2	EX -SHOALING,TIDAL
SAJ	Tampa Bypass	S2	EN
SAJ	Kissimmee	S3	EN,SH -D.S. EROSION
SAM	Tombigbee & Trib		EN,SH,CS -SILTING
SAS	Dunn Br.	S3	EX -ONE SIDE,GOOD
SAW	Swift Cr.	S3	CS,EN -GOOD
SAW	Neuse R.	M3	FC,BP,SH -STILLING BASIN PROBLEM
SAW	Ararat R.	M4	HI -BENCH EXCAVATION
SAW	Broad Cr.	S3	CS,EN -TIDAL EFFECTS
SPL	San Jacinta	S	SU,BP,TR -LEVEE FAILURE
SPL	Lytle & Cajon	M5	LV,TR -FAN,AGGRADATION,BRAIDED
SPL	Devil,Warm	M3	DO,SU,BP,EN,LV -AGGRADATION
SPL	Santa Maria	M3,M4	LV,CS,TR -ANGLED FLOW LV FAILURE
SPL	Lytle & Warm	M4,M5	SU,BP,EX,XC -AGGRADATION
SPK	Stoney Cr.		CHANGES DS OF DAM

(Continued)

(Sheet 3 of 4)

Table G1 (Concluded)

DISTRICT	STREAM NAME	TYPE	IMPROVEMENT CODES & COMMENTS
SPK	Corte Madera	M3,M4	AGGRADATION AT DS END (TIDAL)
SPK	Morman Slough	M1,M2	EN,LV,BP,DI,DO -DEGRADA DS DAM
SPK	L. San Joaquin	M4	LV,CS,BP,XC,GC -BANK CAVING
SPN	Alameda Cr.	S2	EN,BP,LV,FC,SH,XC,GC -RIP FAIL
SPN	San Lorenzo	S4->S1	SU,EN,DE,LV,BP -SILTATION
SPN	Sandy Prairie		RIPRAP TOE FAILURE
SPN	Salinas	M4,M5	TR,CS,EN,BP,PI,LV -LV FAIL,SED.
SPN	Rodeo Cr.	M2	SU,EN,BP -SILTATION
SPN	Russian R.	M2,M4	FC -VERY ACTIVE,MEANDERS
SPN	Mad R.	B4	CS,LV,BP -VERY ACTIVE,MEANDERS
SPN	Eel R.		ACTIVE,RIP FAIL,LV FAIL
SWA	Los Animas	S4	LV,TR -MEANDERING,TOE EROSION
SWA	Grenada	M4	EN,EX,LV -RIPRAP FAIL,FLANKING
SWA	Albuquerque DC	ARROYO	DO,SU,XC,BP -SED AT TRANSITION
SWA	Rio Grande	S4	LV,BP,EN,EX,TR -JACKS,DEGR.
SWA	Socorro DC	ARROYO	DO,XC,SU,BP -SEDIMENTATION
SWA	San Vecente		TOE CUTTING,BANK FAILURE
SWA	SE El Paso		PERCHED RIVER BETWEN LEVEES
SWF	Buffalo Cr.		HEADCUTTING
SWG	Lavach R.	M3	EN,LV -AGGRADATION
SWG	Bray's Bayou	M2,M3	AL,SH,SU -CAPACITY PROBLEMS
SWT	Joe Cr.	M1	EN,SU,BP -RIP FAIL,HEADCUTTING

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